INSTRUCTION MANUAL

SYSTEM 816
MULTI-CHANNEL FILTER

WAVETEK

WAVETEK SAN DIEGO, INC.

9045 Balboa Ave., San Diego, CA 92123

INSTRUCTION MANUAL

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MULTI-CHANNEL FILTER

EFFECTIVITY

Information in this manual is applicable to System 816 mainframes with serial numbers 1233401 and higher, and to System 816 filter cards with serial numbers 1233301 and higher. For mainframes with serial numbers lower than 1233401 the specifications apply only when used with 10 Hz to 150 kHz filter cards. Any changes in design subsequent to the publication of this manual will be documented by addenda shipped with the manual.

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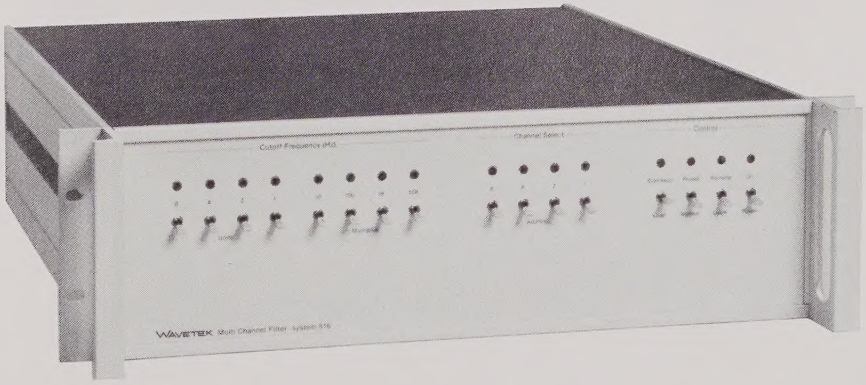

Cutoff Frequency (Hz)
Channel Select
Control
WAVETEK Multi Channel Filter System 816

Figure I-I. System 8I6 Multi-Channel Filter.

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

System 816 is a versatile, fully-programmable, multi-channel filter system capable of processing up to 16 independent analog signal channels. Two 48 db/octave responses are available: an 8-pole Butterworth and an 8-pole Bessel. The Butterworth low-pass configuration may be altered to high-pass, and thus, by combining two channels, bandpass and band-reject filters may also be realized.

Among its many applications, System 816 is widely used in spectrum analysis for band-limiting analog signals prior to sampling and analog-to-digital conversion to prevent the "aliasing" of out-of-band components into the frequency band of interest. In this application, as the sampling frequency is changed, the cutoff frequency of the filter is automatically programmed to a corresponding value typically less than half the sampling frequency, to obtain optimum out-of-band signal rejection.

System 816 is ideally suited to automated data acquisition and signal processing in such fields as sonar, vibration, speech, medicine, geophysics, and process control.

System 816 consists of a mainframe and a number of plug-in filter cards. The mainframe provides local, on-card, and remote programming, readout facilities, power, and input/output connections for up to 16 independent channels. One filter card is required for each channel. The user may thus purchase the mainframe and as many filter cards as initially required. System 816 may then be expanded in the future by purchasing additional filter cards.

This manual contains complete specifications, installation and operation instructions, theory of operation, maintenance and calibration procedures, an electrical parts list, and component location and schematic illustrations.

BUTTERWORTH. The Butterworth filter has maximally-flat amplitude response suitable for frequency-domain applications. Its cutoff frequency (fc) is defined as the frequency at which the amplitude response is down 3 db. The attenuation rate (rolloff) beyond the cutoff frequency is 48 db/octave.

BESSEL. The Bessel filter is a linear-phase filter. Because of this characteristic the filter approximates a constant time delay up to its cutoff frequency. This filter is suitable for time-domain applications because of its inherent ability to pass transient waveforms with a minimum of distortion and overshoot. Cutoff frequency (fc) of an 8th-order Bessel filter is defined as the frequency at which the phase shift is equal to 360°; its amplitude response is down 3 db at 0.5 fc.

1-2. DESCRIPTION.

ELECTRICAL. System 816 operates from either 115 or 230 volts ac, 50-60 Hz, and consumes 200 watts maximum power. A rear-panel slide switch selects the nominal line voltage. A fan draws air through the instrument for cooling. The case of the instrument is grounded through the power cord, but signal and programming ground is isolated from the case through a .47 uF capacitor. Cutoff frequency is set by an 8-4-2-1 code which selects the units, and a one-of-four decade multiplier. Channel selection is made by 8-4-2-1 code. Filter cards contain two memories, each of which stores the 8 bits necessary to specify the cutoff frequency. One of the memories consists of eight miniature switches mounted on the filter card. By setting these switches to a particular frequency value, a frequently-needed setting is stored in a non-volatile form. The other memory consists of digital registers which can be loaded either by front-panel toggle switches or remote-programming lines. With PRESET selected (either front panel or programming) the filter cutoff frequency is determined by the on-card switch memory. When PRESET is not selected (NORMAL) the filter cutoff frequency is determined by the data loaded into the digital registers. The cutoff frequency stored in the digital registers can either be loaded into any one selected channel, or into all channels in common. When power to the unit is turned on, the digital registers are automatically loaded to their highest cutoff frequency.

Except for POWER, all controls (CUTOFF FREQUENCY, CHANNEL SELECT, COMMON/LOAD, PRESET/NORMAL, and REMOTE/LOCAL) can be set either by front-panel toggle switches or through programming lines connected to a rear-panel connector. Red light-emitting diodes (LEDs) located above each toggle switch indicate COMMON, PRESET, and/or REMOTE operation, as well as the channel selected at the front panel and the cutoff frequency of that channel.

PHYSICAL. The System 816 cabinet is 5-1/4 inches high by 17 inches wide (19 inches including rack mounts). The instrument is 19 inches deep behind the rack mounts and 20-3/4 inches deep overall. Weight with no filter cards installed is 24-1/2 pounds. Filter cards weigh approximately 1 pound each.

The POWER switch and all operating controls and indicators are located at the front panel. The rear panel contains the fan intake and exhaust vents, power connector and fuse holder, 115/230 VAC line selector switch, one 36-pin programming connector, and two 36-pin signal connectors. The mating connectors for signal and programming are fastened in place when shipped from the factory.

Most of the electrical components are mounted on two printed-circuit boards, in addition to the filter cards. The motherboard holds power supply components and sockets for the plug-in front-panel scanner assembly and all the plug-in filter cards. Etched fingers at the rear of the motherboard accommodate the programming and signal connectors through the rear panel. The scanner assembly, mounted directly behind the front panel, holds the control circuits and the front-panel toggle switches and indicators. The front panel and scanner assembly remove easily for service.

As many as sixteen filter cards can be installed in each System 816 mainframe. Card extractors mounted on each filter card simplify insertion and extraction. Two miniature-switch assemblies, each containing four switches, are mounted on each card for setting PRESET cutoff frequency. These switches are factory-set at their highest frequency value. Eight pairs of miniature plug-in jumpers on Butterworth cards allow the filter cards to be set individually for low-pass or high-pass filtering. Cards are shipped from the factory in low-pass configuration. Bessel cards are hard wired for low-pass filtering only.

1-3. OPTIONS.

System 816 filter cards are available in four overlapping frequency ranges. Table 1-1 lists the option numbers for each range for the mainframe and both the Butterworth and Bessel filter cards. The only differences in mainframes are the front-panel MULTIPLIER markings. Cards with different frequency ranges may be used in a common mainframe, but this fact must be suitably noted by the user in his software or operating instructions. The overall frequency range of each of the filter cards consists of four ranges which are selectable by the CUTOFF FREQUENCY controls. (These four ranges are designated A-B-C-D in this manual.) Table 1-2 lists the frequency settings possible with each card. Each option number has four ranges listed below it.

Table I-1. Frequency Range Options.

Mainframe	Filter Cards Butterworth	 Bessel	Overall Frequency Range
11	01	05	10 Hz to 150 KHz
12	02	06	1 Hz to 15 KHz
13	03	07	0.1 Hz to 1.5 KHz
14	04	N.A.	0.01 Hz to 150 Hz

Table I-2. Nominal Cutoff Frequency (Hz).

<table>
<tr><td colspan="3"></td><th colspan="4">OPTIONS 01, 05, 11</th></tr>
<tr><td colspan="2"></td><th colspan="4">OPTIONS 02, 06, 12</th><td></td></tr>
<tr><td></td><th colspan="4">OPTIONS 03, 07, 13</th><td colspan="2"></td></tr>
<tr><th colspan="4">OPTIONS 04, 14</th><td colspan="3"></td></tr>
<tr><td>0.01</td><td>0.1</td><td>1</td><td>10</td><td>100</td><td>1K</td><td>10K</td></tr>
<tr><td>0.02</td><td>0.2</td><td>2</td><td>20</td><td>200</td><td>2K</td><td>20K</td></tr>
<tr><td>0.03</td><td>0.3</td><td>3</td><td>30</td><td>300</td><td>3K</td><td>30K</td></tr>
<tr><td>0.04</td><td>0.4</td><td>4</td><td>40</td><td>400</td><td>4K</td><td>40K</td></tr>
<tr><td>0.05</td><td>0.5</td><td>5</td><td>50</td><td>500</td><td>5K</td><td>50K</td></tr>
<tr><td>0.06</td><td>0.6</td><td>6</td><td>60</td><td>600</td><td>6K</td><td>60K</td></tr>
<tr><td>0.07</td><td>0.7</td><td>7</td><td>70</td><td>700</td><td>7K</td><td>70K</td></tr>
<tr><td>0.08</td><td>0.8</td><td>8</td><td>80</td><td>800</td><td>8K</td><td>80K</td></tr>
<tr><td>0.09</td><td>0.9</td><td>9</td><td>90</td><td>900</td><td>9K</td><td>90K</td></tr>
<tr><td>0.10</td><td>1.0</td><td>10</td><td>100</td><td>1K</td><td>10K</td><td>100K</td></tr>
<tr><td>0.11</td><td>1.1</td><td>11</td><td>110</td><td>1.1K</td><td>11K</td><td>110K</td></tr>
<tr><td>0.12</td><td>1.2</td><td>12</td><td>120</td><td>1.2K</td><td>12K</td><td>120K</td></tr>
<tr><td>0.13</td><td>1.3</td><td>13</td><td>130</td><td>1.3K</td><td>13K</td><td>130K</td></tr>
<tr><td>0.14</td><td>1.4</td><td>14</td><td>140</td><td>1.4K</td><td>14K</td><td>140K</td></tr>
<tr><td>0.15</td><td>1.5</td><td>15</td><td>150</td><td>1.5K</td><td>15K</td><td>150K</td></tr>
</table>

1-4. SPECIFICATIONS.

Typical Butterworth and Bessel filter characteristics are given in Table 1-3. Figures 1-2 and 1-3 are graphs of typical amplitude and phase responses. Table 1-4 provides operating specifications for System 816.

Table 1-3. Typical Characteristics.

Butterworth Low-Pass Transfer Function:

Frequency	Amplitude	Phase
DC	0 db	0°
$\sqrt{2}/2$ fc	0 db	-220°
fc	-3 db	-360°
$\sqrt{2}$ fc	-24 db	-495°
2 fc	-48 db	-570°

Butterworth High-Pass Response: mirror image of low-pass response except for highest MULTIPLIER range (not recommended for high-pass operation)

Bessel Low-Pass Transfer Function:

Frequency	Amplitude	Phase
DC	0 db	0°
0.25 fc	-0.7 db	-90°
0.5 fc	-3 db	-180°
0.75 fc	-7 db	-270°
fc	-13.6 db	-360°

	Butterworth	Bessel
Peak Overshoot:	16%	0.5%
Settling Time (plus 3 mSec programming time):		
To ± 1% of final value	3.1/fc	1.6/fc
To ± 0.1% of final value	5.1/fc	2.3/fc
To ± 0.01% of final value	7.1/fc	3.2/fc

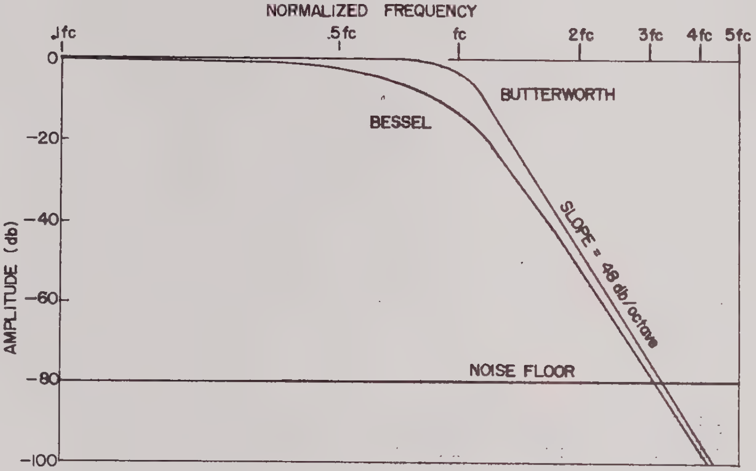


Figure 1-2. Typical Amplitude Response.

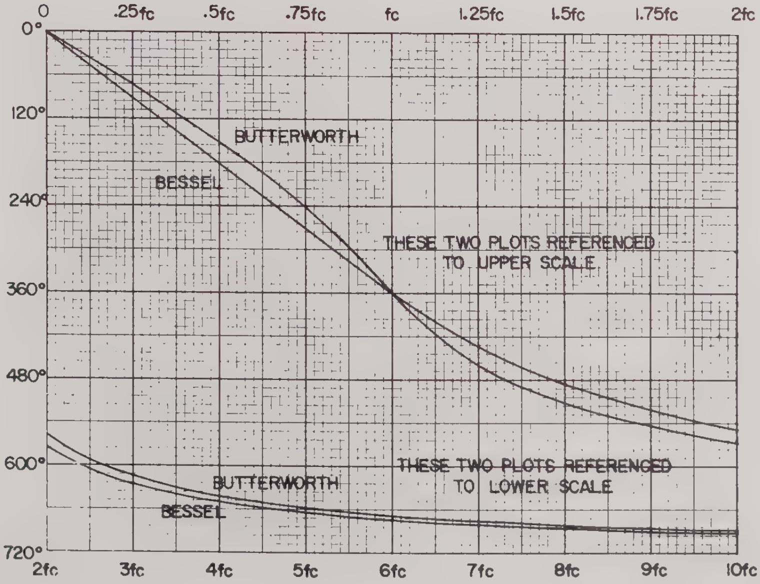


Figure 1-3. Typical Phase Response.

Table 1-4. Specifications.

CUTOFF FREQUENCY

Resolution: cutoff frequency units may be programmed to fifteen discrete values, from 1 to 15

Range: four multiplier ranges may be programmed (see Table 1-1). The cutoff frequency in Hertz is the product of the Units setting and the Multiplier setting.

Accuracy: ±2%, (±3% in highest multiplier position)

Stability: ±200 ppm°C (typical)

DC GAIN

0 db ± 0.25 db

TYPICAL PHASE MATCH BETWEEN FILTER CARDS

±2° or ±2%, whichever is greater.

INPUT CHARACTERISTICS

Circuit: single ended, DC isolated from chassis

Impedance: 1 megohm shunted by 50 pF

Full-Scale Signal: ± 10 volts (20 V, pk-pk)

Absolute Maximum Input: ± 100 volts (AC + DC)

OUTPUT CHARACTERISTICS

Circuit: single ended, DC isolated from chassis

Impedance: 50 ohms

Full-Scale Signal: ± 10 volts (20 V, pk-pk)

Output Current: ± 20 mA into 50 ohms (typical)

Distortion: less than 0.1%

Noise and Hum (including Crosstalk): 80 dB below full-scale signal with inputs shorted and 100 KHz detector bandwidth.

DC Offset: 0 ± 10 millivolts at any f_c setting.

Drift: 0.5 mV/°C, typical

Table 1-4. Specifications (Cont).

REMOTE PROGRAMMING

Requires a maximum of 17 bits (lines) for full programming of the 16-channel system as follows:

Four bits select channel to be programmed

Four bits select cutoff frequency units

Four bits select cutoff frequency range multiplier

One bit each for Device Select, Common Program, Load Command, Preset Command, and Load Acknowledge

All input lines represent two standard TTL loads. Each line is terminated with a 3.3K pull-up resistor to +5 V DC. An unconnected (open) line will assume logic "0" (high)

Inverted TTL Logic Levels:

logic "1" is 0.0 V to +0.8 V (low)

logic "0" is +2.0 V to +5.0 V (high)

Cutoff Frequency Units: four lines, 8-4-2-1 code, selected by logic "1"

Cutoff Frequency Multiplier: four lines, selected by logic "1", weight dependent on frequency range of card being programmed

10 Hz to 150 KHz card	X10	X100	X1K	X10K
1 Hz to 15 KHz card	X1	X10	X100	X1K
0.1 Hz to 1.5 KHz card	X0.1	X1	X10	X100
0.01 Hz to 150 Hz card	X0.01	X0.1	X1	X10

If two or more Multiplier values are programmed, the highest programmed value operates.

Channel Select: four lines, 8-4-2-1 code, selected by logic "1"

Device Select: one line, low selects remote-program control, high selects front-panel control

Table 1-4. Specifications (Cont).

Common Program: one line, low allows Load only to channel determined by Channel Select lines, high selects identical loading of all channels

Load Command: one line; normally held high, low loads Cutoff Frequency data. When held high all Cutoff Frequency data which has been loaded is stored internally; programming inputs need not be held constant.

Preset Command: one line; normally held high, low enables on-card cutoff-frequency switch control of fc and disables digital register control of fc (digital registers can still be loaded)

Load Acknowledge (Output): one line, normally high. Pulled low through the collector of an NPN transistor to indicate to the programmer that data has been loaded, and remains low as long as both Device Select and Load Command are low.

Programming Delay: less than 3 mS for any function

ELECTRICAL AND PHYSICAL CHARACTERISTICS

Primary Power: 115 or 230 VAC ± 10%, 50-60 Hz, 200 watts maximum (with 16 filter cards installed)

Dimensions: cabinet is 5-1/4 inches (13.3 cm) high, 17 inches (43.2 cm) wide, 19 inches (48.3 cm) deep; mounts in standard RETMA rack. Depth behind rack mount is 19 inches (48.3 cm) including rear-panel components.

Weight: mainframe, 24-1/2 lb (11.14 kg); filter cards, each 1 lb (0.45 kg)

Operating Temperature: 0°C to +50°C ambient

Storage Temperature: -20°C to +70°C

Connectors: all input, output, and programming connections are made at the rear panel via three p.c.-edge connectors. Mating connectors (CINCH-JONES No. 50-36A-30) are supplied with the mainframe.

SECTION II

OPERATION

2-1. INTRODUCTION.

System 816 is electrically operational as shipped from the factory. The following paragraphs describe inspection, power requirements, interconnection, and operation.

2-2. INSPECTION.

This system was carefully inspected and tested prior to shipment. It was operated for a number of hours to reduce the probability of early failure. After unpacking the unit, it should be carefully inspected for shipping damage. Check especially for broken controls and connectors, and dented or scratched cabinet parts. Should the instrument show any signs of damage, file a claim with the carrier immediately. Preserve the carton and packing materials; they will be required by the carrier.

It is recommended that conformance to specifications be verified upon receipt. In case of discrepancies, refer to the warranty at the beginning of this manual.

2-3. INSTALLATION AND POWER REQUIREMENTS.

System 816 is designed primarily for installation in a standard 19-inch RETMA rack. Depth of the rack should be at least 22 inches to allow 3 inches minimum behind the instrument for cables and ventilation. Ambient temperature within the rack must not exceed +50°C while the instrument is operating. Other paragraphs in this section describe connections and switch settings which should be made before the unit is installed.

CAUTION

Always ensure that the 115/230 volt switch is set for the nominal line voltage and that a fuse of the proper

> rating is installed in the instrument. If the switch is set incorrectly or a fuse of the wrong rating is used, the instrument may be damaged or fail to operate.

The instrument will operate from either 115 or 230 volts ac, 50-60 Hz. Conversion for line voltage is performed with a slide switch mounted on the rear panel (see Figure 2-1). The unit is shipped with the switch set for 115 volts. To change the setting, insert a small-blade screwdriver in the switch slot and move switch to expose 115 for 115 Vac operation, or 230 for 230 Vac operation.

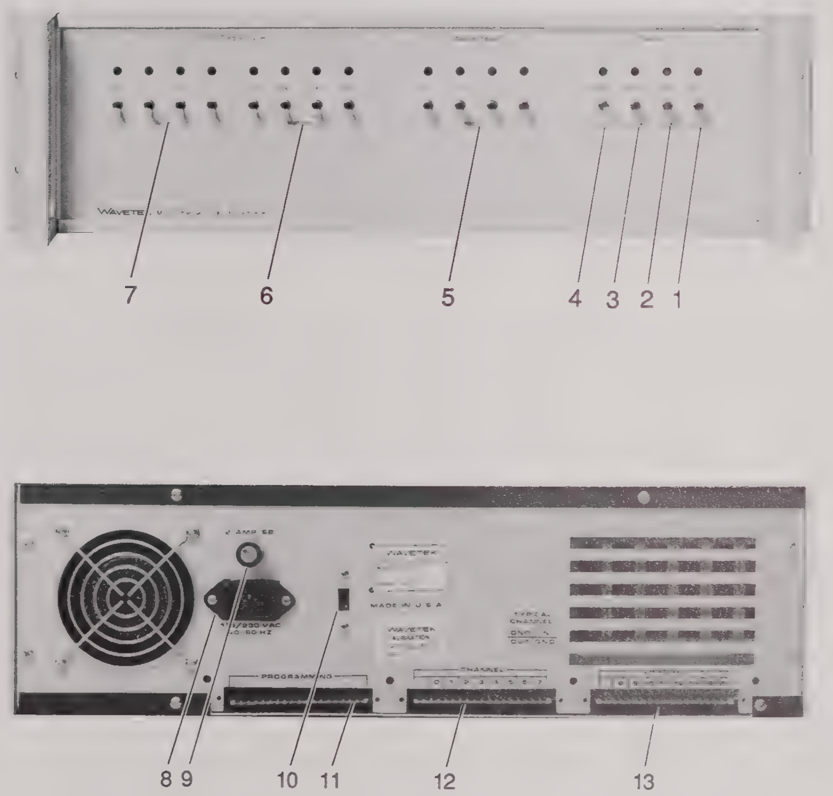
The instrument is shipped with a 2-amp slow-blow fuse for 115-volt operation. If the unit is to be operated from a 230-volt supply, the fuse should be replaced with a 1-amp slow-blow fuse (not supplied).

WARNING

> In keeping with standard safety practice, the case of the instrument is grounded through the power cord. If the instrument must be connected to a two-wire receptacle, use a parallel-ground adapter and connect the short lead to ground.

2-4. CONTROLS AND INDICATORS.

System 816 controls and indicators are shown in Figure 2-1 and described in Table 2-1. The descriptions in Table 2-1 and the following paragraphs are not intended to be complete operating instructions, but only general information applying to all modes of operation. Paragraphs 2-5, 2-6, and 2-7 describe filter-card settings, interconnection, and typical operating procedures.



WAVETEK
7
6
5
4
3
2
1
2 AMP SB
WAVETEK
MADE IN U.S.A
PROGRAMMING
CHANNEL
0 1 2 3 4 5 6 7
8
9
10
11
12
13

Figure 2-1. Controls and Indicators.

Table 2-1. Controls And Indicators.

NUMBER	ITEM	DESCRIPTION
1	POWER ON Switch	A two-position toggle switch which supplies power to the instrument. The digital register memories on all filter cards are loaded to their highest cutoff-frequency value when power is turned on. A red light-emitting diode (LED) located above the switch indicates that power is on.
2	LOCAL/REMOTE Switch	A two-position toggle switch; in LOCAL the unit is controlled by front-panel switches, in REMOTE the unit is controlled by programming commands through the rear-panel PROGRAMMING Connector. With this switch at LOCAL, remote control can still be selected via the PROGRAMMING Connector. A red LED indicates REMOTE control, whether selected at the front panel or remotely.
3	NORMAL/PRESET Switch	A two-position toggle switch; in NORMAL the cutoff frequency is controlled by digital registers on each filter card. These registers can be

Table 2-1. Controls And Indicators (Cont).

NUMBER	ITEM	DESCRIPTION
		loaded either by front-panel switches or remote-programming lines. In PRESET the cutoff frequency is set by switches on each filter card. A frequently-used program can be stored with the on-card switches, eliminating the need to reprogram the digital register each time the instrument is turned on. With switch at NORMAL, PRESET can still be selected via the PROGRAMMING Connector. A red LED indicates PRESET operation, whether selected at the front panel or remotely.
4	LOAD/COMMON Switch	A three-position toggle switch, normally in the middle (off) position. In the momentary-contact LOAD position cutoff-frequency data is loaded into the digital register of a single selected channel. In COMMON, all channels are loaded at the same time; the digital registers follow the front-panel switch settings as long as the switch is left in COMMON. A red LED indicates COMMON.

Table 2-1. Controls And Indicators (Cont).

NUMBER	ITEM	DESCRIPTION
5	CHANNEL SELECT Switches	Four two-position toggle switches which select the channel (0-15) whose cutoff frequency is to be set by a front-panel LOAD command. In REMOTE (or LOCAL) operation, the cutoff frequency displayed on the front panel is that of the channel selected by the CHANNEL SELECT Switches. Four red LEDs indicate the address of the selected channel in 8-4-2-1 code.
6	CUTOFF FREQUENCY MULTIPLIER Switches	Four two-position toggle switches which select one of four overlapping frequency ranges. If more than one multiplier is selected, only the highest selected value operates (see Table 2-2). Four red LEDs indicate the range of the filter card selected by the CHANNEL SELECT Switches, whether that range is set by the on-card switches, at the front panel, or remotely.

Table 2-1. Controls And Indicators (Cont).

NUMBER	ITEM	DESCRIPTION
7	CUTOFF FREQUENCY UNITS Switches	Four two-position toggle switches which select the units of the cutoff frequency in Hertz (see Table 2-2). Four red LEDs indicate the cutoff frequency units (in 8-4-2-1 code) of the filter card selected by the CHANNEL SELECT Switches, whether that value is set by the on-card switches, at the front panel, or remotely.
8	Power Connector	Supplies primary power and grounds the chassis of the instrument.
9	Fuse Holder	Holds power-line fuse; 2-amp slow-blow for 115 V, 1-amp slow-blow for 230 V.
10	115/230 Volt Switch	Sets the instrument for the nominal line voltage.
11	PROGRAMMING Connector	A 36-pin connector used to connect programming signals to System 816 (see Table 2-5).
12 & 13	CHANNEL Connectors	Two 36-pin connectors used to make signal input and output connections (see Tables 2-3 and 2-4).

CHANNEL SELECTION. Channels are numbered 0 through 15, and are selected in 8-4-2-1 code as shown in Table 2-2a.

CUTOFF FREQUENCY SETTING. Table 2-2 lists the codes which select the CUTOFF FREQUENCY UNITS and MULTIPLIER. In LOCAL (front-panel) control, "1" is selected by setting the toggle switch to its upper position, toward the selected unit or multiplier range. Tables 1-3 and 2-5 provide data concerning the signal levels of the "1" (active) state for REMOTE control.

NOTES

> A UNITS value of "0" (zero) should be avoided. Selecting a UNITS value of "0" will saturate the filter amplifiers.
>
> It is recommended that the highest MULTIPLIER range (D) not be used in high-pass configuration.

It can be seen from Table 2-2 that if more than one multiplier range is selected, either at the front panel or remotely, only the highest selected range operates. This means that two ranges can be controlled by one switch or programming line. For example, selection between the B and D ranges can be made by selecting both ranges. When D range is needed, leave both ranges on, and only the D range operates. When B range is needed, simply turn the D range off and B range will then operate.

NOTE

> Only one MULTIPLIER range may be selected by the on-card PRESET Switches. The other three ranges must be turned off.

Table 2-2. CUTOFF FREQUENCY And CHANNEL SELECT Switch Settings.

a. CUTOFF FREQUENCY UNITS And CHANNEL SELECT

CHANNEL	CUTOFF FREQUENCY (Hz) UNITS	CODE 8-4-2-1
0	AVOID	0 0 0 0
1	1	0 0 0 1
2	2	0 0 1 0
3	3	0 0 1 1
4	4	0 1 0 0
5	5	0 1 0 1
6	6	0 1 1 0
7	7	0 1 1 1
8	8	1 0 0 0
9	9	1 0 0 1
10	10	1 0 1 0
11	11	1 0 1 1
12	12	1 1 0 0
13	13	1 1 0 1
14	14	1 1 1 0
15	15*	1 1 1 1
	*This setting should also be used when the filter is operated as a DC Amplifier	

b. CUTOFF FREQUENCY MULTIPLIER

CUTOFF FREQUENCY (Hz) MULTIPLIER	CODE
DC AMPLIFIER*	0 0 0 0
A	0 0 0 1
B	0 0 1 X
C	0 1 X X
D**	1 X X X

X=either 0 or 1 except for the on-card PRESET Switches. For these switches only one range can be selected, the others must be switched off.

* Filter cards may be operated as DC Amplifiers only in low-pass configuration, avoid this setting in high-pass configuration.

** Avoid this setting in high-pass configuration.

Certain values of cutoff frequency can be obtained by either of two combinations of switch settings. For instance, 1 KHz can be obtained with a UNITS value of 1 and a range MULTIPLIER of X1000, or with a UNITS value of 10 and a range MULTIPLIER of X100. Generally it is recommended to use the higher UNITS value and the lower MULTIPLIER (UNITS of 10, MULTIPLIER of X100 in this example).

SETTLING TIME. The longest settling time of the filters occurs when switching to the lowest MULTIPLIER range (A). To obtain fastest settling when switching to a lower MULTIPLIER, proceed as follows:

1. Select desired MULTIPLIER range.
2. Temporarily select a UNITS value of 15.
3. Select desired UNITS value.

SPECIAL MODES. Filter bypass can be obtained by selecting no MULTIPLIER range. In this configuration the filter operates as a DC amplifier with unity gain. A UNITS value of 15 should be selected to minimize noise pickup. Either Butterworth or Bessel filter cards can be used as DC amplifiers, but the Butterworth card must be set for low-pass operation.

INDICATORS. The LEDs above the CUTOFF FREQUENCY toggle switches indicate the cutoff frequency of the channel selected by the front-panel toggle switches. Therefore, changing the CUTOFF FREQUENCY Switches will not affect the cutoff frequency (hence, the LEDs) until receipt of a LOAD Command or unless COMMON is selected. The LEDs will not light if there is no filter card in the selected channel.

The LEDs above the CHANNEL SELECT Switches indicate the address of the channel selected by the front-panel switches only.

2-5. FILTER CARD SETTINGS AND INSTALLATION.

ON-CARD CUTOFF FREQUENCY SWITCHES. Figure 2-2 shows the location of the on-card switches which set the cutoff frequency in PRESET mode. Cards are shipped with a units value of 15 and the highest multiplier range selected.

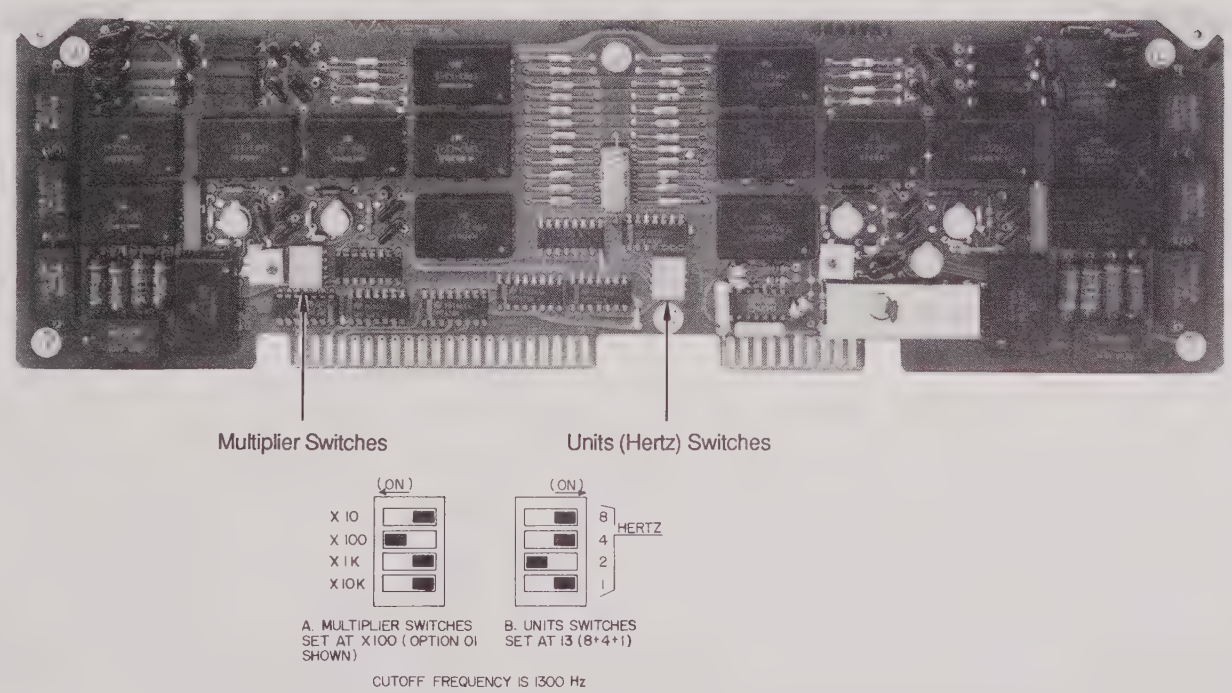
To set the units, slide the switches to the right to select units from 1 to 15 as required. The example in Figure 2-2b shows a units value of 13 selected; the 8, 4, and 1 switches are set to the right, toward the numbers etched on the printed-circuit board.

To set the multiplier, set the desired switch to the left, toward the multiplier range value printed on the label to the left of the switches. The example in Figure 2-2a shows a multiplier value of X100 selected on a filter card having an overall frequency range of 10 Hz to 150 KHz. Filter cards in other frequency ranges have labels which correspond to the range of the card. Unlike operation in LOCAL and REMOTE modes, only one multiplier range may be selected; the other ranges must be turned off.

LOW PASS/HIGH PASS JUMPERS. On Butterworth filter cards eight pairs of plug-in jumpers on each card determine low-pass or high-pass operation. (Cards are shipped in low-pass configuration. Bessel filter cards are hard-wired for low-pass operation only.) Figure 2-3 shows the locations of the jumpers. Each jumper set consists of five jacks soldered to the filter card in a "W"-shaped pattern, and two jumper plugs. For explanation purposes, the pins are designated a, b, c, d, e in Figure 2-3a. For low-pass operation, connect pin a to pin c and pin b to pin d. For high-pass operation, connect pin a to pin d and pin b to pin a.

NOTE

All eight jumper sets on any one card must be set in the same way, either low-pass or high-pass.

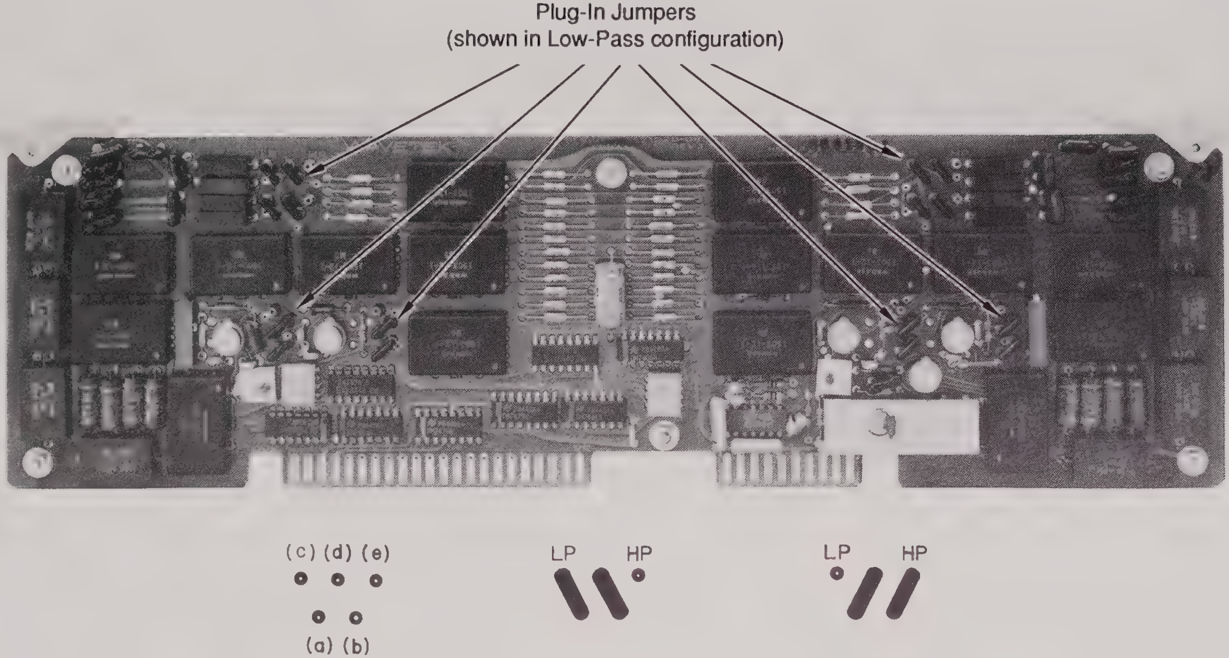

Multiplier Switches
Units (Hertz) Switches
(ON)
X 10
X 100
X 1K
X 10K
(ON)
8
4
2
1
HERTZ

A. MULTIPLIER SWITCHES SET AT X100 (OPTION 01 SHOWN)

B. UNITS SWITCHES SET AT 13 (8+4+1)

CUTOFF FREQUENCY IS 1300 Hz

Figure 2-2. On-Card (Preset) Cutoff Frequency Switches.


Plug-In Jumpers
(shown in Low-Pass configuration)
(c) (d) (e)
(a) (b)
LP
HP
LP
HP

A. JUMPER PINS (LETTERS ARE NOT ON PRINTED-CIRCUIT BOARD)

B. ONE PAIR OF JUMPERS IN LOW-PASS CONFIGURATION

C. ONE PAIR OF JUMPERS IN HIGH-PASS CONFIGURATION

Figure 2-3. Plug-In Jumpers For Low Pass/High Pass.

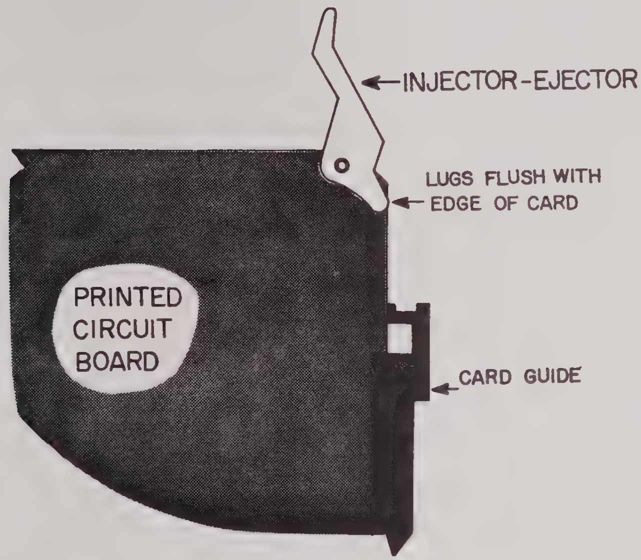
INSTALLATION.

WARNING

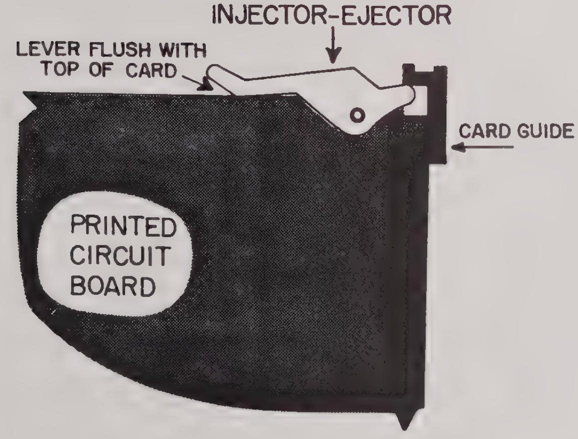
Exposed electrical connections within the instrument may connect to potentially dangerous voltages, even when the POWER Switch is turned off. Exercise caution when working within any electrical equipment.

Filter Cards are installed with the component side facing to the right of the instrument. Channel numbers are etched on the motherboard adjacent to the rear socket for each filter card. A filter card may be installed in any channel; cards need not be installed sequentially. To install filter cards in System 816, proceed as follows (see Figure 2-4):

1. Remove two screws which secure the top cover to the rear panel, and slide the top cover to the rear.
2. Position injector-ejectors on each side of card so that engaging lugs are flush with side edge of card (Figure 2-4a).
3. Slide card into guide slots for desired channel.
4. Ensure that printed-circuit board contacts are properly aligned with both sockets on the motherboard.
5. Push both injector-ejector levers down at the same time to lock the card in place (Figure 2-4b). With the levers flush with the top of the card, press down on both injector-ejectors to ensure that card is fully seated.
6. To remove a card, pull both injector-ejector levers up at the same time to unseat the card.


INJECTOR-EJECTOR
LUGS FLUSH WITH EDGE OF CARD
PRINTED CIRCUIT BOARD
CARD GUIDE

a. Injector-Ejector Set for Insertion.


INJECTOR-EJECTOR
LEVER FLUSH WITH TOP OF CARD
CARD GUIDE
PRINTED CIRCUIT BOARD

b. Filter Card Locked in Place.

Figure 2-4. Filter Card Installation.

2-6. INTERCONNECTION.

SIGNAL. All input and output signal connections are made through two rear-panel connectors. The connectors are printed-circuit edge type, with 18 contacts on the top edge, and 18 on the bottom. Input signal and ground lines alternate on the top row, and output signal and ground lines alternate on the bottom row. Table 2-3 lists the pin connections for the CHANNEL 0-7 Connector, and Table 2-4 lists the pin connections for the CHANNEL 8-15 Connector. Pin designations are, from left to right, 1 to 18 on the top row and A to V on the bottom row.

Signal connections should generally be made with coaxial cable, with the cable shield soldered to the ground pin next to the signal pin. In some applications, where crosstalk or noise pickup is not a serious consideration, twisted pairs may be adequate for signal connections.

PROGRAMMING. Remote programming controls are supplied to System 816 at the rear panel through a printed-circuit edge connector. The connector has two rows of 18 contacts, designated from left to right. The top row of contacts, pins 1 through 18, is used for the programming input and output signals. Programming ground connections are made at any or all of the bottom row of contacts, pins A through V. Table 2-5 lists the pin connections for the PROGRAMMING Connector and provides a description of each signal. Remote programming inputs are low active ("1" state). A "1" is 0V to 0.8V, and a "0" is +2V to +5V.

Programming connections should generally be made through twisted pairs of leads to prevent false data from being loaded through coupling between lines. All the ground lines can be tied together at the programming instrument if necessary. In some applications, with short lead lengths (generally less than 2 feet), twisted pairs may not be necessary.

Cable clamps supplied with the unit may be used to support signal and programming cables.

Table 2-3. CHANNEL 0-7 Signal Connector.

PIN	DESCRIPTION	PIN	DESCRIPTION
1	No Connection	A	No Connection
2	No Connection	B	No Connection
3	Channel 0 Ground (Input)	C	Channel 0 Output
4	Channel 0 Input	D	Channel 0 Ground (Output)
5	Channel 1 Ground (Input)	E	Channel 1 Output
6	Channel 1 Input	F	Channel 1 Ground (Output)
7	Channel 2 Ground (Input)	H	Channel 2 Output
8	Channel 2 Input	J	Channel 2 Ground (Output)
9	Channel 3 Ground (Input)	K	Channel 3 Output
10	Channel 3 Input	L	Channel 3 Ground (Output)
11	Channel 4 Ground (Input)	M	Channel 4 Output
12	Channel 4 Input	N	Channel 4 Ground (Output)
13	Channel 5 Ground (Input)	P	Channel 5 Output
14	Channel 5 Input	R	Channel 5 Ground (Output)
15	Channel 6 Ground (Input)	S	Channel 6 Output
16	Channel 6 Input	T	Channel 6 Ground (Output)
17	Channel 7 Ground (Input)	U	Channel 7 Output
18	Channel 7 Input	V	Channel 7 Ground (Output)

Table 2-4. CHANNEL 8-15 Signal Connector.

PIN	DESCRIPTION	PIN	DESCRIPTION
1	No Connection	A	No Connection
2	No Connection	B	No Connection
3	Channel 8 Ground (Input)	C	Channel 8 Output
4	Channel 8 Input	D	Channel 8 Ground (Output)
5	Channel 9 Ground (Input)	E	Channel 9 Output
6	Channel 9 Input	F	Channel 9 Ground (Output)
7	Channel 10 Ground (Input)	H	Channel 10 Output
8	Channel 10 Input	J	Channel 10 Ground (Output)
9	Channel 11 Ground (Input)	K	Channel 11 Output
10	Channel 11 Input	L	Channel 11 Ground (Output)
11	Channel 12 Ground (Input)	M	Channel 12 Output
12	Channel 12 Input	N	Channel 12 Ground (Output)
13	Channel 13 Ground (Input)	P	Channel 13 Output
14	Channel 13 Input	R	Channel 13 Ground (Output)
15	Channel 14 Ground (Input)	S	Channel 14 Output
16	Channel 14 Input	T	Channel 14 Ground (Output)
17	Channel 15 Ground (Input)	U	Channel 15 Output
18	Channel 15 Input	V	Channel 15 Ground (Output)

Table 2-5. PROGRAMMING Connector.

FUNCTION	PIN	DESCRIPTION
Channel Select 1	1	Low active. Select the channel (0-15), in 8-4-2-1 code, whose cutoff frequency is to be programmed. (The CHANNEL SELECT Indicators are always controlled by the front-panel CHANNEL SELECT Switches.)
Channel Select 2	3	
Channel Select 4	5	
Channel Select 8	7	
Cutoff Frequency 1	10	Low active. Select the cutoff-frequency units (Hertz) in 8-4-2-1 code. The code for 0 is meaningless, and should be avoided.
Cutoff Frequency 2	11	
Cutoff Frequency 4	12	
Cutoff Frequency 8	13	
Multiplier A	14	Low active. Select the cutoff-frequency range multiplier. The weights of A-B-C-D are in a 1-10-100-1000 ratio (see Tables 1-1, 1-2, and 1-4). If no multiplier is selected, the unit operates as a dc amplifier (low-pass configuration only).
Multiplier B	15	
Multiplier C	16	
Multiplier D	17	
Device Select	2	Low active. Enables remote programming independently of the front-panel LOCAL/REMOTE Switch. If left high (open), Remote can still be selected by the LOCAL/REMOTE Switch. The REMOTE Indicator indicates remote control, whether selected by the Device Select line or LOCAL/REMOTE Switch.

Table 2-6. PROGRAMMING Connector (Cont).

FUNCTION	PIN	DESCRIPTION
Preset	4	Low active. Disables cutoff-frequency data set at the front panel or remotely, and enables cutoff-frequency data set by on-card switches. If left high (open), Preset can still be selected by the NORMAL/PRESET Switch. The PRESET Indicator indicates Preset, whether selected by the Preset line or NORMAL/PRESET Switch.
Common Program	6	High active. Allows cutoff-frequency data to be loaded into all channels simultaneously upon receipt of a Load Command. If held low (ground), the Load Command loads data only into the channel selected by the Channel-Select lines. The COMMON Indicator will light only for the duration of Load Command.
Load Command	8	Low active. Loads cutoff-frequency data (units and multiplier) into the digital register of either the selected channel or all channels as determined by Common Program. Cutoff-frequency data is stored while Load Command is high.
Load Acknowledge	9	Low active. This output line, normally high, is pulled low to signal the programmer that data has been loaded; remains low as long as both Device Select and Load Command are active.

NOTE: "Low active" is ground, "high active" is open. Programming ground connections are made on the bottom row of contacts, pins A through V. Both programming and ground connections should be made through A.W.G. #26 wire, or heavier.

2-7. TYPICAL OPERATING PROCEDURES.

OPERATING MODE SELECTION. System 816 operating mode is controlled by two functions, NORMAL/PRESET, and LOCAL/REMOTE (see Table 2-6). Selection of NORMAL or PRESET determines the source of the cutoff frequency operating on the filter card. When NORMAL is selected, fc is determined by the digital registers on each filter card. When PRESET is selected, fc is determined by the miniature switches mounted on each filter card. PRESET can be selected either by the front-panel NORMAL/PRESET Switch or through the PROGRAMMING Connector. The front-panel PRESET Indicator will light whenever PRESET is enabled, either at the front panel or remotely.

Selection of LOCAL or REMOTE determines the input source for the digital registers on each card. When LOCAL is selected, fc data is loaded into the digital registers from the front-panel CUTOFF FREQUENCY Switches. The channel to be loaded is addressed by the front-panel CHANNEL SELECT Switches. When REMOTE is selected, fc data is loaded into the digital registers through eight PROGRAMMING lines, four to select the UNITS in 8-4-2-1 code, and four to select one of four MULTIPLIER ranges. The channel to be loaded is addressed through four PROGRAMMING lines in 8-4-2-1 code. REMOTE can be selected either by the front-panel LOCAL/REMOTE Switch or through the PROGRAMMING Connector. The front-panel REMOTE Indicator will light whenever REMOTE is enabled, either at the front panel or remotely.

Table 2-6. Operating-Mode Control.

Source Of Operating fc			Digital Register Input Source		
Mode	NORMAL/ PRESET Switch	PRESET Line	Mode	LOCAL/ REMOTE Switch	DEVICE SELECT Line
Preset	PRESET	X	Remote	REMOTE	X
	X	Low		X	Low
Normal	NORMAL	High	Local	LOCAL	High

X indicates that setting is irrelevant.

In REMOTE mode, cutoff frequency data on the PROGRAMMING lines is loaded upon receipt of a Load Command (0.1uS minimum duration). With Common Program activated the cutoff frequency data is loaded into all channels simultaneously upon receipt of the Load Command. In LOCAL mode, cutoff frequency data set by the CUTOFF FREQUENCY Switches is loaded into the selected channel by pressing down the momentary-contact LOAD Switch, or all channels can be loaded with the same cutoff frequency at once by selecting COMMON.

The front-panel CUTOFF FREQUENCY Indicators show the cutoff frequency operating in the channel addressed by the CHANNEL SELECT Switches, regardless of whether that cutoff frequency was loaded locally, remotely, or by the on-card switches.

NOISE LEVEL. Noise in any one filter card is at least 80 db below the full-scale signal level. When multiple filter cards are used, the signal-to-noise ratio may be somewhat degraded. Noise levels are a function of the number of filter cards being interconnected, the type of interconnection (cascade, parallel, or combination), and bandwidth. The -80 db noise floor in Figures 2-5 through 2-9 is shown for reference only.

INCREASING ROLLOFF RATE (BUTTERWORTH). Filter cards can be cascaded to increase rolloff to 96 db per octave. Figure 2-5 provides a block diagram of the filter-card interconnection and the resultant frequency-response plot. Filter cards are cascaded by connecting the output of one channel to the input of another through the rear-panel connectors. Adjacent channels should be used to minimize the length of wire. Do not connect the signal ground pins together.

For each filter card cascaded at a given fc, the output signal is down 3 db at fc. Figure 2-5 shows that with two filters, the output signal level is 6 db below the 0 db reference (input signal) level at fc.

BANDPASS FILTERING (BUTTERWORTH). Two filter cards, one in high-pass and one in low-pass, can be cascaded to provide bandpass filtering. Figure 2-6 provides the block diagram and frequency-response plot. When cascading filters for bandpass operation, the input signal should be connected to the high-pass filter, and the output of the high-pass filter is then connected to the input of the low-pass filter. Figure 2-6 shows that with one filter determining each of the two cutoff frequencies the rolloff rate is 48 db/octave.

BAND-REJECT FILTERING (BUTTERWORTH). Two filter cards, one in high-pass and one in low-pass, can be connected in parallel to provide band-reject filtering. Figure 2-7 provides the block diagram and frequency-response plot. Whenever two (or more) filters are connected in parallel, the outputs should be summed through 1K resistors. These should be 1% tolerance, non-inductive, 1/2 watt resistors. Note that this results in a 6 db insertion loss between the input and output signal levels.

DOUBLE BANDPASS FILTERING (BUTTERWORTH). Filters can be cascaded, with the cascades connected in parallel to provide two (or more) passbands. Figure 2-8 provides the block diagram and frequency-response plot for one possible combination of filters. In the example in Figure 2-8, two pairs of filters are used in the top branch to provide a 96 db/octave rolloff for the passband determined by that branch.

DOUBLE BAND-REJECT FILTERING (BUTTERWORTH). Parallel filter configurations can be cascaded to provide two (or more) stopbands. Figure 2-9 provides the block diagram and frequency-response plot for one possible combination of filters. Filters 1 and 2 comprise one band-reject filter, and the summed output is connected to the inputs of filters 3 and 4, which comprise the second band-reject filter. Note that the output reference level is 12 db below the input level.

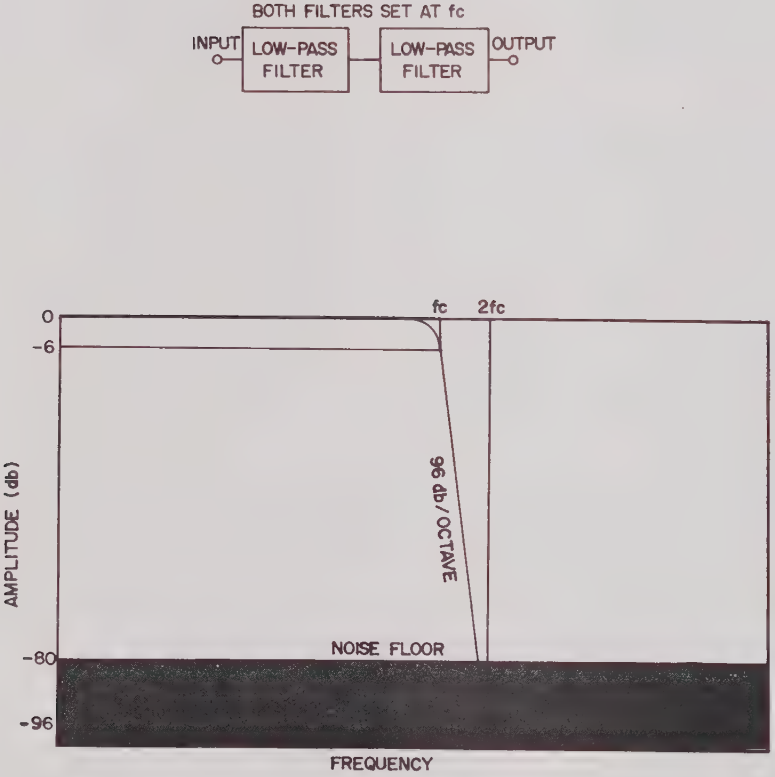


Figure 2-5. Increasing Rolloff Rate.

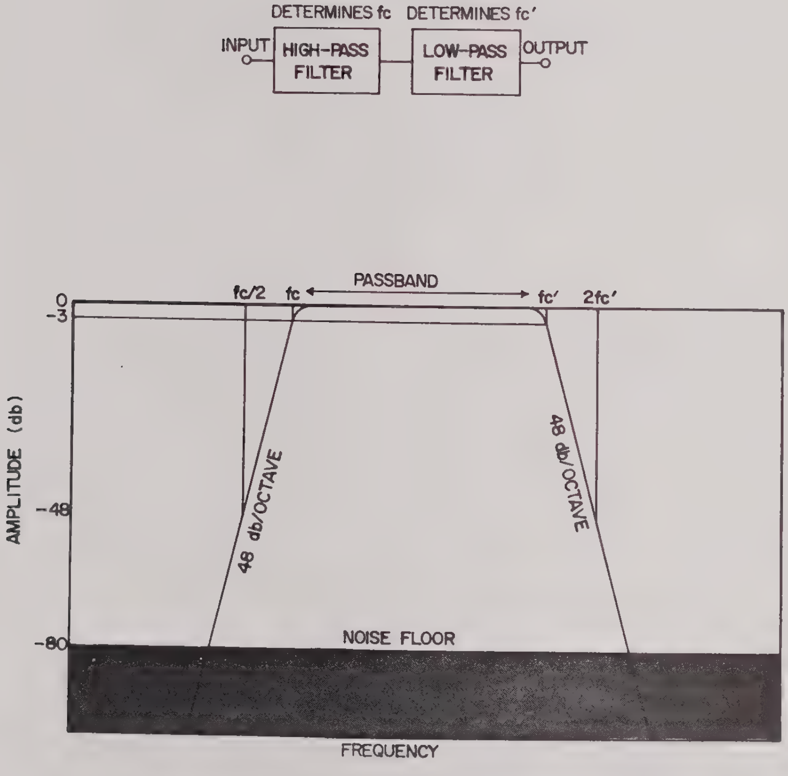

DETERMINES fc
DETERMINES fc′
INPUT
HIGH-PASS FILTER
LOW-PASS FILTER
OUTPUT
PASSBAND
fc/2
fc
fc′
2fc′
0
-3
-48
-80
AMPLITUDE (db)
48 db/OCTAVE
48 db/OCTAVE
NOISE FLOOR
FREQUENCY

Figure 2-6. Bandpass Filtering.

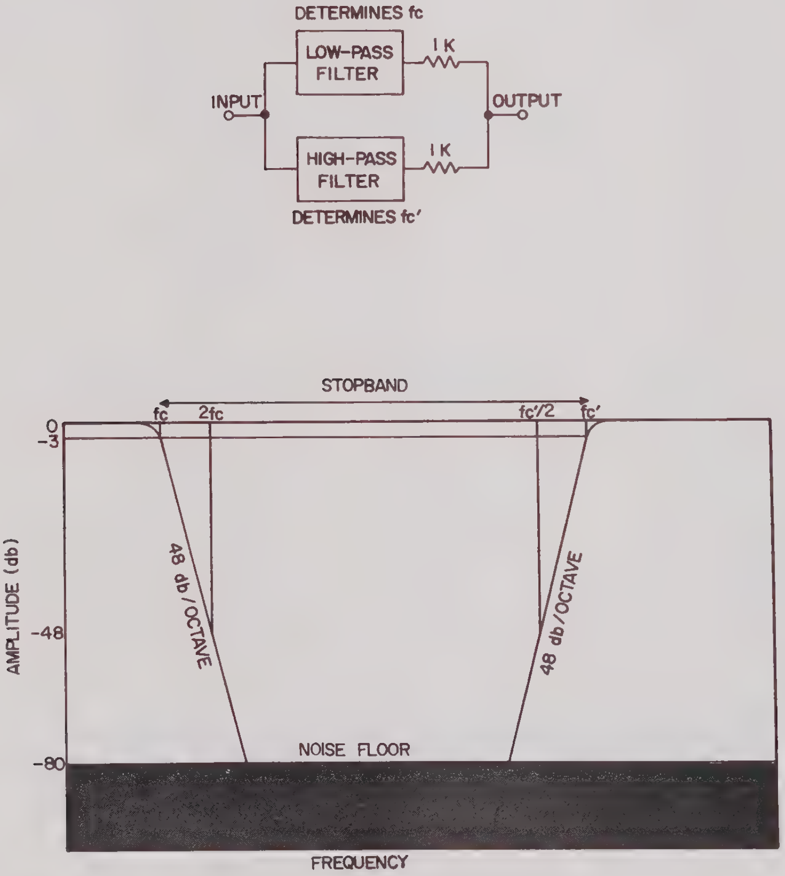

DETERMINES fc
LOW-PASS FILTER
1 K
INPUT
OUTPUT
HIGH-PASS FILTER
1 K
DETERMINES fc'
STOPBAND
fc
2fc
fc'/2
fc'
0
-3
-48
-80
AMPLITUDE (db)
48 db/OCTAVE
48 db/OCTAVE
NOISE FLOOR
FREQUENCY

Figure 2-7. Band-Reject Filtering.

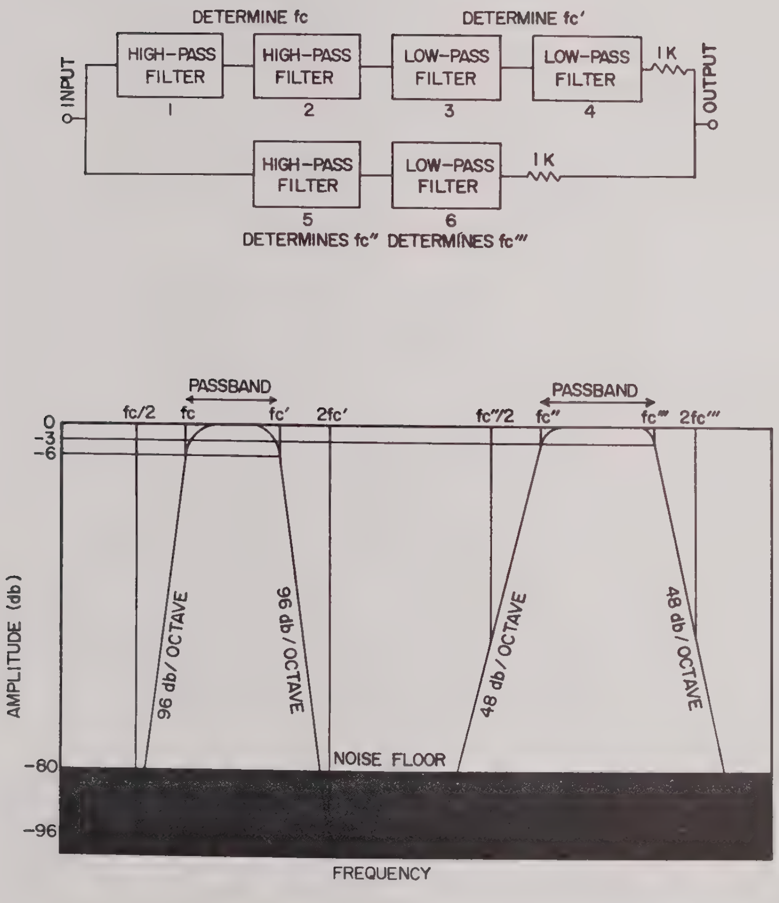

DETERMINE fc
DETERMINE fc'
INPUT
HIGH-PASS FILTER 1
HIGH-PASS FILTER 2
LOW-PASS FILTER 3
LOW-PASS FILTER 4
1 K
OUTPUT
HIGH-PASS FILTER 5
LOW-PASS FILTER 6
1 K
DETERMINES fc"
DETERMINES fc'''
PASSBAND
PASSBAND
fc/2
fc
fc'
2fc'
fc"/2
fc"
fc'''
2fc'''
0
-3
-6
-80
-96
AMPLITUDE (db)
96 db/ OCTAVE
96 db / OCTAVE
48 db / OCTAVE
48 db / OCTAVE
NOISE FLOOR
FREQUENCY

Figure 2-8. Double Bandpass Filtering.

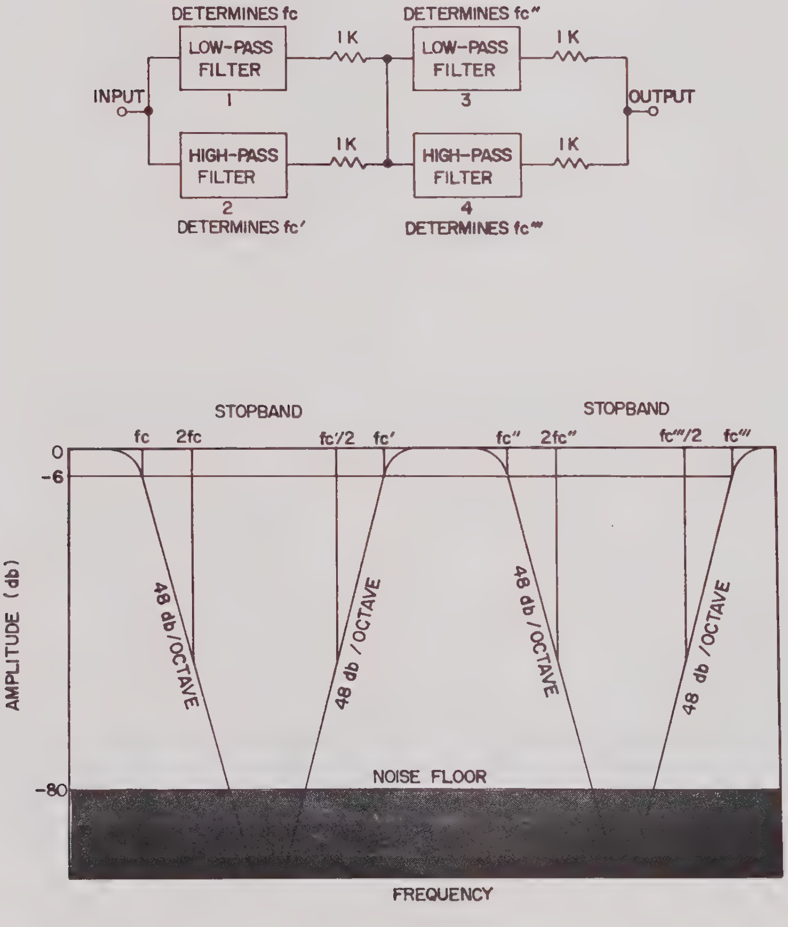
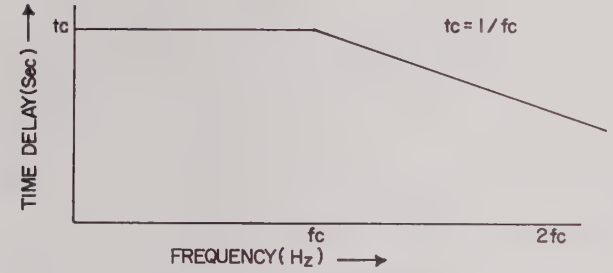
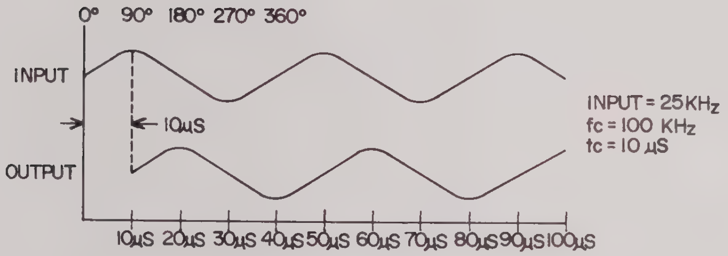

DETERMINES fc
LOW-PASS FILTER
1
1 K
DETERMINES fc''
LOW-PASS FILTER
3
1 K
INPUT
OUTPUT
HIGH-PASS FILTER
2
DETERMINES fc'
1 K
HIGH-PASS FILTER
4
DETERMINES fc'''
1 K
STOPBAND
STOPBAND
fc
2fc
fc'/2
fc'
fc''
2fc''
fc'''/2
fc'''
0
-6
-80
AMPLITUDE (db)
48 db/OCTAVE
48 db /OCTAVE
48 db /OCTAVE
48 db /OCTAVE
NOISE FLOOR
FREQUENCY

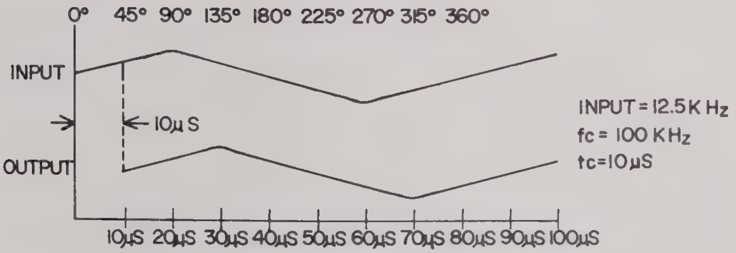
Figure 2-9. Double Band-Reject Filtering.



A. TIME DELAY VS FREQUENCY


0° 90° 180° 270° 360°
INPUT
10µS
OUTPUT
INPUT = 25KHz
fc = 100 KHz
tc = 10 µS
10µS 20µS 30µS 40µS 50µS 60µS 70µS 80µS 90µS 100µS

B. 25 KHz INPUT


0° 45° 90° 135° 180° 225° 270° 315° 360°
INPUT
10µS
OUTPUT
INPUT = 12.5K Hz
fc = 100 KHz
tc = 10µS
10µS 20µS 30µS 40µS 50µS 60µS 70µS 80µS 90µS 100µS

C. 12.5 KHz INPUT

Figure 2-10. Bessel Time Delay.

TIME DELAY (BESSEL). The phase shift of Bessel filters is linear between DC and cutoff frequency (fc). An input frequency equal to fc is shifted 360°, an input frequency equal to 1/2 fc is shifted 180°, an input frequency equal to 1/4 fc is shifted 90°, etc. This linear phase-shift characteristic allows use of Bessel filters as time-delay elements.

Figure 2-10a shows that the time delay (i.e., the derivative of phase) is constant at any fc for input frequencies up to fc. Figures 2-10b and 2-10c show the result of the 10 uS time delay obtained with a cutoff frequency of 100 KHz. The input frequency in Figure 2-10b is 25 KHz, which is 1/4 the cutoff frequency. Therefore, the output is shifted 90° from the input, which is equivalent to 1/4 period, or 10 uS. The input frequency in Figure 2-10c is 12.5 KHz, which is 1/8 the cutoff frequency. Therefore, the output is shifted 45° from the input, which is equivalent to 1/8 period, or 10 uS. Regardless of the input frequency (up to fc), the time delay is always equal to 1/fc.

Two or more filter cards can be cascaded to lengthen the time delay. Note that output signal amplitude decreases as the input frequency approaches fc (see Figure 1-2), which may result in excessive attentuation near fc.

SECTION III

PRINCIPLES OF OPERATION

3-1. INTRODUCTION.

This section contains a block diagram and description of System 816, and a description of the filter card. The block diagram represents the functional operation of the instrument, and does not necessarily show actual circuit configuration. A line on the block diagram or a schematic which is labeled as a signal (e.g., LOCAL, CHANNEL SELECT 8, LOAD ACKNOWLEDGE, etc.) is high (+5 V) whenever that condition is true (operating). A negation symbol (e.g., $\overline{\text{COMMON}}$, CUTOFF FREQUENCY UNITS $\overline{1}$ $\overline{2}$ $\overline{4}$ $\overline{8}$, $\overline{\text{LOAD}}$, etc.) indicates that the signal is low (ground) whenever that condition is true (operating).

3-2. BLOCK DIAGRAM ANALYSIS.

Figure 3-1 is a block diagram of System 816. Switching functions shown are performed by logic circuits. Except for Filter-Card components, all blocks represent components on the Scanner Assembly. In the following paragraphs, reference designations in parentheses are the actual components represented by blocks.

Gate OR1 (U7A) determines whether the instrument responds to front-panel or remote-programming controls. If either front-panel or remote-programming REMOTE is selected, the REMOTE Indicator lights and switch sections a, b, c, and d are set at REMOTE.

Switch "a" (U24 & U27) selects whether the eight Cutoff Frequency bus lines (four Units, four Multiplier) are controlled by the front-panel CUTOFF FREQUENCY Switches or the programming lines.

Switch "b" (U11) selects the source of the channel address for the Load Command, and switch "c" (U9A) selects the source of the Load Command. There are two BCD-to-

Decimal Decoders (U15 & U16), and each one decodes the 1-2-4 BCD data into one of eight channels (0 through 7, or 8 through 15). The Load Gates (U12A, U12B, & U12D) gate the Load Command through to the proper BCD-to Decimal Decoder depending on whether or not the Channel Select "8" line is active.

System 816 also has provision for loading all channels simultaneously. Switch "d" (U9B) selects the source of this control. When selected at the front panel this signal is called Common, and when selected remotely it is called Common Program. Common Program is gated through AND 1 (U1D) only during a remote Load Command, while Common remains as long as the front-panel COMMON/LOAD Switch is at COMMON. Gate OR 2 (U20, U21, U22, & U23) gates the Load Command to one selected channel or to all 16 channels. When a Load Command is supplied to a Filter Card, the data on the eight Cutoff Frequency bus lines is loaded into the Digital Memory (U1 & U4) on that card. Gate OR 3 (U1A) selects whether the data stored on the Digital Memory or the On-Card Switches controls the cutoff frequency. If Preset is selected, either at the front panel or remotely, the PRESET Indicator lights and switch "e" (U2 & U5) is set at PRESET.

The eight inputs to the Relay Drivers are also gated out to light the front-panel CUTOFF FREQUENCY Indicators. The Read Command is supplied to the Memory Data Out Gates (U7 & U8) on only one Filter Card, as selected by the front-panel CHANNEL SELECT Switches through the BCD-to-Decimal Decoder (U13 & U14). The four inputs to this Decoder also light the CHANNEL SELECT Indicators. This enables the operator to read the cutoff frequency of any channel even though automated programming equipment may be controlling System 816.

3-3. FILTER CARD DESCRIPTION.

Figure 3-2 is a simplified schematic of a System 816 filter card. The 8th-order filter consists of an input circuit and four cascaded 2nd-order filter sections. Each 2nd-order section consists of an operational amplifier and feedback and coupling circuits. The schematic is shown for a low-pass configuration, with a single section shown in high-pass configuration in Insert A. The only difference between low-pass and high-pass consists of the interchanging of the coupling capacitors and resistors.

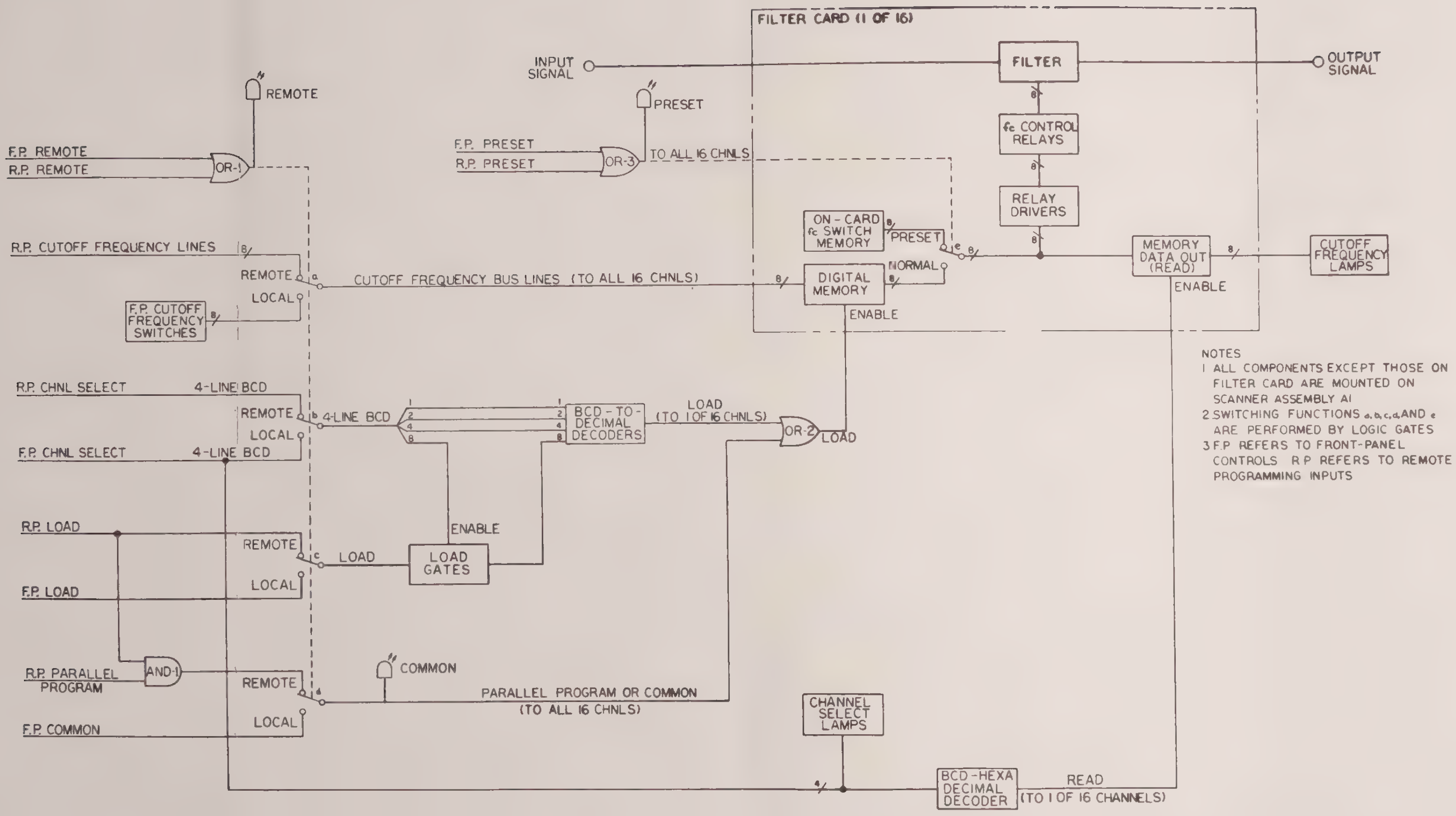
Although the simplified schematic applies to both Butterworth and Bessel filters, the principles of operation are somewhat different and are described separately. The Butterworth description applies to Bessel filters except as noted in the Bessel description.

BUTTERWORTH FILTER CARDS. The four filter sections of the Butterworth filter are identical, except for component values of R3 and R4. The transfer function for a single section is: $\frac{Vout}{Vin} = A \frac{\omega_0^2}{s^2 + 2\beta\omega_0 s + \omega_0^2}$ where the angular frequency (ω_0) = 1/RC, DC gain (A) = 1 + R3/R4, and damping factor (β) = $1 - \frac{R3}{2R4}$. It can be seen that cutoff frequency is controlled through selection of different RC coupling values, R1, C1, R2, and C2. The resistors are selected by the UNITS controls, and the capacitors are selected by the MULTIPLIER controls.

The damping factor (β) is set by the values of R3 and R4, which are selected to satisfy the mathematic requirements for synthesizing an 8th-order filter with maximally-flat amplitude response (-3 db at fc).

The DC gain (A) is also a function of the values of R3 and R4. The gain of each section is given on the simplified schematic above each section. The total gain for the four sections is approximately 6.88. The combination of the input attenuator and input amplifier provides a gain of $\frac{1}{6.88}$ so that the overall gain from input to output is unity (0 db).

BESSEL FILTER CARDS. The four filter sections of the Bessel filter are not identical, the difference being that each section has a different cutoff frequency as well as a different DC gain. The transfer function for each section is the same as for Butterworth filters: $\frac{Vout}{Vin} = A \frac{\omega_0^2}{s^2 + 2\beta\omega_0 s + \omega_0^2}$ but both angular frequency (ω_0) and damping factor (β) are different for each section. These two parameters are selected to satisfy the mathematic requirements for synthesizing an 8th-order filter with maximally-flat phase shift.


FILTER CARD (1 OF 16)
INPUT SIGNAL
FILTER
OUTPUT SIGNAL
REMOTE
PRESET
F.P. REMOTE
R.P. REMOTE
OR-1
F.P. PRESET
R.P. PRESET
OR-3
TO ALL 16 CHNLS
fc CONTROL RELAYS
RELAY DRIVERS
ON-CARD fc SWITCH MEMORY
PRESET
NORMAL
e
DIGITAL MEMORY
ENABLE
MEMORY DATA OUT (READ)
ENABLE
CUTOFF FREQUENCY LAMPS
8
R.P. CUTOFF FREQUENCY LINES
REMOTE
a
LOCAL
CUTOFF FREQUENCY BUS LINES (TO ALL 16 CHNLS)
F.P. CUTOFF FREQUENCY SWITCHES
R.P. CHNL SELECT
4-LINE BCD
REMOTE
b
4-LINE BCD
LOCAL
F.P. CHNL SELECT
4-LINE BCD
1
2
4
8
BCD-TO-DECIMAL DECODERS
LOAD (TO 1 OF 16 CHNLS)
OR-2
LOAD
ENABLE
R.P. LOAD
REMOTE
c
LOAD
LOAD GATES
F.P. LOAD
LOCAL
R.P. PARALLEL PROGRAM
AND-1
REMOTE
d
COMMON
PARALLEL PROGRAM OR COMMON (TO ALL 16 CHNLS)
LOCAL
F.P. COMMON
CHANNEL SELECT LAMPS
4
BCD-HEXA DECIMAL DECODER
READ (TO 1 OF 16 CHANNELS)

NOTES
1 ALL COMPONENTS EXCEPT THOSE ON FILTER CARD ARE MOUNTED ON SCANNER ASSEMBLY A1
2 SWITCHING FUNCTIONS a, b, c, d, AND e ARE PERFORMED BY LOGIC GATES
3 F.P. REFERS TO FRONT-PANEL CONTROLS. R.P. REFERS TO REMOTE PROGRAMMING INPUTS

Figure 3-1. System 816 Block Diagram.

NOTES
1 THE SIMPLIFIED SCHEMATIC IS SHOWN IN LOW-PASS CONFIGURATION INSERT A SHOWS ONE STAGE IN HIGH-PASS CONFIGURATION
2 MULTIPLIER CONTROLS SELECT ONE OF FOUR POSSIBLE VALUES FOR C1 AND C2. UNITS CONTROLS CONNECT ONE, TWO, THREE, OR FOUR RESISTORS IN PARALLEL TO DETERMINE VALUES OF R1 AND R2

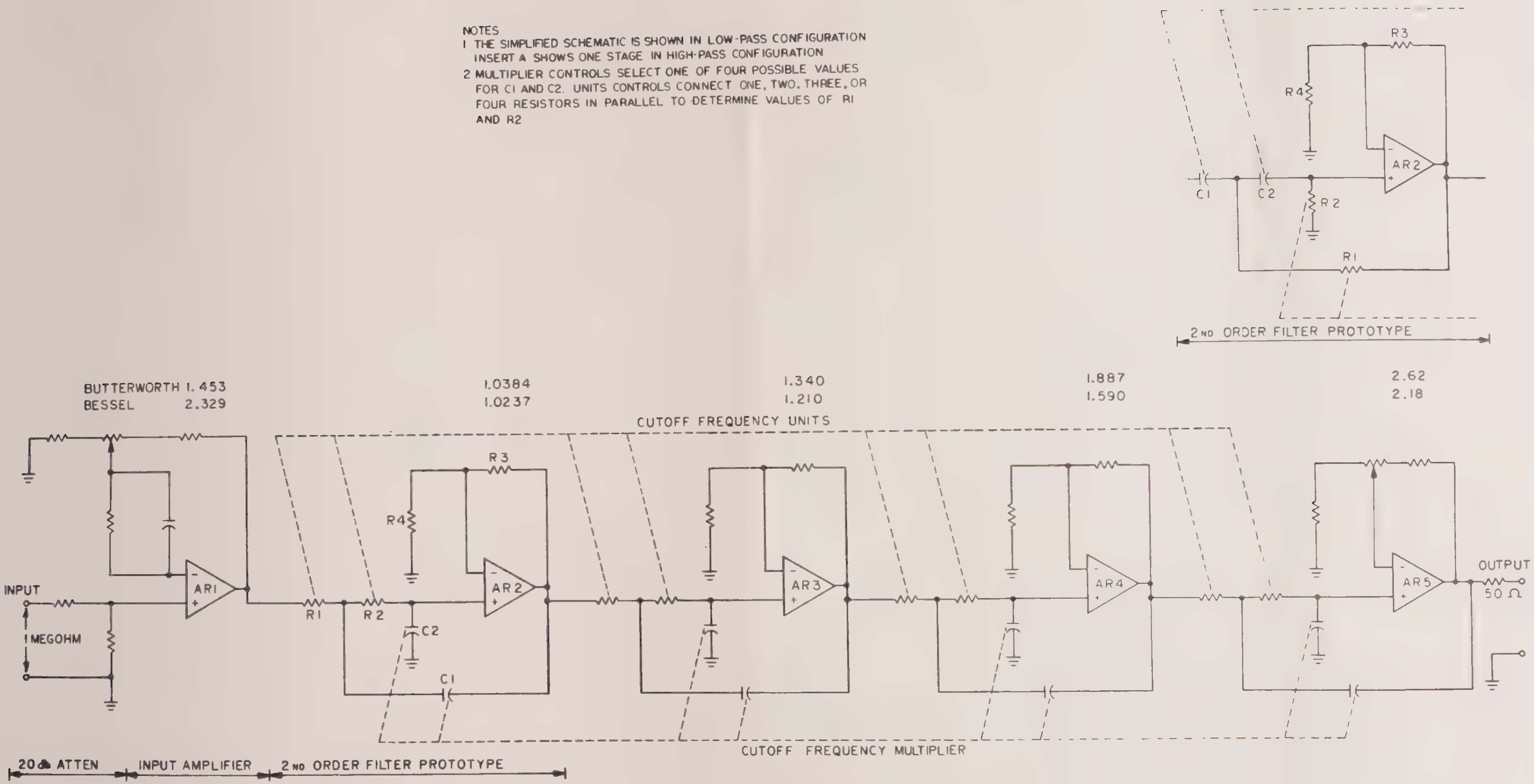

R3
R4
AR2
C1
C2
R2
R1
2ND ORDER FILTER PROTOTYPE
BUTTERWORTH 1.453
BESSEL 2.329
1.0384
1.0237
1.340
1.210
1.887
1.590
2.62
2.18
CUTOFF FREQUENCY UNITS
AR1
INPUT
1 MEGOHM
R1
R2
R4
R3
AR2
C2
C1
AR3
AR4
AR5
OUTPUT
50 Ω
CUTOFF FREQUENCY MULTIPLIER
20 db ATTEN
INPUT AMPLIFIER
2ND ORDER FILTER PROTOTYPE

Figure 3-2. Simplified Filter Schematic.

SECTION IV

MAINTENANCE AND CALIBRATION

4-1. INTRODUCTION.

Integrated-circuit design and printed-circuit manufacturing techniques utilized in System 816 produce a highly reliable instrument which should seldom require repair or calibration. The fan motor is lubricated for the service life of the instrument. When used in a dusty environment, the interior of the instrument may require periodic cleaning with a vacuum cleaner or dry low-pressure compressed air. The exterior of the instrument can be cleaned with a mild detergent and water solution.

Corrective maintenance consists of procedures designed to correct problems that have resulted in the failure of System 816 to operate properly. Usually these procedures include troubleshooting, repair, and calibration. The test values given in the calibration section may also be used for conformance testing.

4-2. TROUBLESHOOTING.

The single most important aspect of troubleshooting is the formulation of a logical approach to locating the source of trouble. The technician should be familiar with the principles of operation, block diagrams, and schematics. If a malfunction is suspected, ensure that the problem is not caused by other equipment connected to System 816.

Check the fuse, power cord, and all switch settings. Confirm that all eight pairs of jumpers on each filter card are set for low-pass or high-pass operation as required. Check the settings of the on-card cutoff frequency switches, particularly the MULTIPLIER switches; only one MULTIPLIER may be on. Ensure that the proper type of filter, either Butterworth or Bessel, of the proper frequency range is being used. Bessel filter cards can be identified by the hard-wired jumpers in place of the plug-in jumpers used on Butterworth filter cards. The frequency range of a filter card is given by the label next to the on-card MULTIPLIER switches.

If System 816 is found to be malfunctioning, check to ensure that plug-in assemblies are correctly aligned and fully seated. Look for loose or broken wiring, bent connector pins, leaking capacitors, cracked printed-circuit boards, and discolored components.

System 816 can be separated into digital control circuits and analog signal circuits. A problem can be isolated to one of these two areas by use of the front-panel controls and indicators. (It may be helpful to refer to the System 816 block diagram.) Set a cutoff frequency value and load it into the channel to be checked. If the front-panel LED readout indicates the correct cutoff frequency, all control logic circuits are functioning properly, and the problem must be located in the relay drivers, relays, or filter circuits. If the front-panel readout does not indicate the cutoff frequency that was loaded, the problem must be located in the logic circuits.

ANALOG SIGNAL CIRCUITS. If the problem is isolated to the analog circuits it can be further isolated with the front-panel controls. (Refer to the simplified schematic of the filter card.) The cutoff frequency is controlled by varying the RC coupling between filter stages. The UNITS controls select the resistors, and the MULTIPLIER controls select the capacitors. Select any one MULTIPLIER range and set the UNITS controls for "1". Monitor the output signal to determine the correct attenuation at cutoff frequency (3 db for Butterworth, 13.6 db for Bessel). Repeat the procedure for UNITS values of "2", "4", and "8". If the cutoff frequency is correct in all cases, the coupling resistors and the relays which select them are all functioning properly. Next, select a UNITS value and check the cutoff frequency for all four MULTIPLIER ranges. This step tests the coupling capacitors and the relays which select them. If the problem cannot be isolated by these steps, it must be in the input circuit or operational amplifiers. The gain values for each amplifier stage given on the simplified filter schematic can be used to further isolate the problem.

DIGITAL CONTROL CIRCUITS. Lines on the scanner and filter card schematics which are labeled as signals (e.g., REMOTE, LOAD, 8, etc.) are high (+5V) whenever that condition is true (operating). Signal lines whose labels include a negation symbol (e.g., $\overline{\text{COMMON}}$, $\overline{\text{REMOTE}}$, $\overline{8}$, $\overline{4}$, $\overline{2}$, $\overline{1}$, etc.) are low (ground) whenever that condition is true (operating). A check for the proper logic levels will typically isolate the problem to a particular component. If a problem appears to exist in more than one area, look for a component common to the problem areas.

4-3. REPAIR.

Repair of System 816 is accomplished using standard printed-circuit repair techniques. Circuit connections are made on both sides of the printed-circuit boards. Therefore, after a component is removed, check for continuity between the circuits on each side of the printed-circuit board. A small "Z" wire may be required if continuity is lost through the hole, and the component to be replaced obscures the lead on the top side of the board.

WARNING

Disconnect the Power cord from the instrument before removing the scanner assembly.

To remove the front-panel scanner assembly, remove the top cover. Remove the two screws which secure the rail over the scanner assembly and remove the rail. Unplug the two power lines which connect to the back of the scanner assembly on the right-hand side (as viewed from the front). Grasp the front panel firmly, and pull the assembly straight up and out of the mainframe. When replacing the scanner assembly be certain to align the printed-circuit contacts with the sockets on the motherboard, and push the assembly firmly and straight into place. Reconnect the two power lines to the assembly.

4-4. CALIBRATION.

System 816 contains three user-servicable adjustments. Ordinarily these will require adjustment only if certain components are replaced. The following paragraphs describe the checking and setting of each adjustment. Potentiometers R4 and R41 on the filter card require readjustment only if R3, R5, R40, or R42 are replaced. Capacitor C20 on the filter card requires readjustment only if C21 is replaced. These are factory-only adjustments, and should not be attempted by the user.

NOTE

The completion of the calibration procedure returns the instrument to correct alignment.

CALIBRATION LIMITS AND TOLERANCES ARE NOT INSTRUMENT SPECIFICATIONS

Instrument specifications are given in Section 1 of this manual.

POWER SUPPLY ADJUSTMENT. Turn the POWER switch on and check the voltage on the +24 volt bus (pin 2 of XA2B-XA17B). Adjust R1 on the motherboard for a reading of +24 volts (+1, -0).

DC OFFSET ADJUSTMENTS. Potentiometers R7 and R43 (Butterworth only) on the filter cards may require readjustment if the operational amplifiers AR1 or AR5 are replaced.

For Butterworth cards, turn the POWER Switch off and connect the four pairs of jumpers on the left side of the filter card for high-pass operation. Turn the POWER Switch on, and set the front-panel controls to COMMON, NORMAL, and LOCAL. Set a UNITS value of "2" and the highest MULTIPLIER range. Connect an oscilloscope probe to the output pin at the rear-panel connector, and set the oscilloscope controls for DC coupling and vertical sensitivity of 0.01 volts/division. Adjust R43 for zero DC offset. Turn the

POWER Switch off, and reconnect all jumpers for low-pass operation. Turn POWER Switch on and adjust R7 for zero DC offset.

For Bessel cards, turn the POWER Switch on, and set the front-panel controls to COMMON, NORMAL, and LOCAL. Set a UNITS value of "2" and the highest MULTIPLIER range. Monitor the output and adjust R7 for zero DC offset.

SECTION V

PARTS AND SCHEMATICS

5-1. DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

5-2. ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

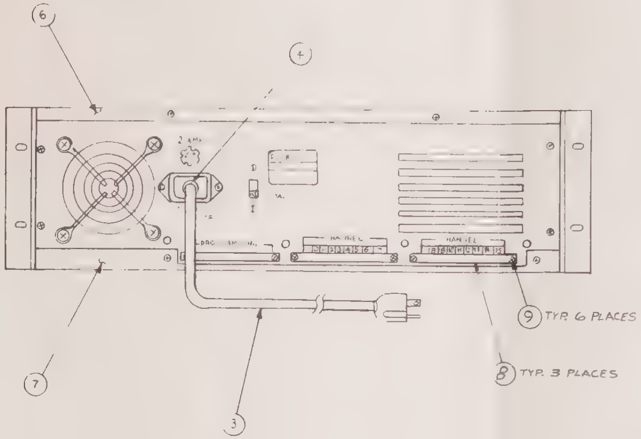
5-3. ORDERING PARTS

When ordering spare parts, please specify part number, next higher assembly, and serial number of the instrument.

NOTE

The number etched into a PC board is the bare board part number. The assembly (board and components on the board) part number is stamped on the board. The assembly drawing number is not necessarily the assembly number. However, the assembly number and the parts list number are always the same.

DRAWING	DRAWING NUMBER
Model 816 Top Dwg and Parts List	02-000-0800
Mainframe Assembly and Parts List	02-002-0800
Mainboard Schematic	03-004-0820
Mainboard Assembly	004.0820
Mainboard Parts List	004.0820
Side Plate Assembly and Parts List	02-002-0860
Card Cage Assembly	02-002-0890
Card Cage Assembly Parts List	002.0890
Scanner Schematic	03-004-0810
Scanner PCA Assembly	02-004-0810
Scanner PCA Parts List	004.0810
Front Panel Assembly and Parts List	02-001-0800
Side Frame Assembly and Parts List	02-002-0867
Rear Panel Assembly	02-002-0875
Rear Panel Parts List	002.0875
Shield Plate Assembly and Parts List	02-002-0870
Butterworth Filter Schematic (10 Hz-150 kHz)	03-004-0830
Butterworth Filter PCB Assembly	02-004-0830
Butterworth Filter Parts List	004-0830
Bessel Filter Schematic (10 Hz-150 kHz)	03-004-0835
Bessel Filter PCB Assembly	02-004-0835
Bessel Filter Parts List	004-0835
Butterworth Filter Schematic (1 Hz-15 kHz)	03-004-0840
Butterworth Filter PCB Assembly	02-004-0840
Butterworth Filter Parts List	004-0840
Bessel Filter Schematic (1 Hz-15 kHz)	03-004-0845
Bessel Filter PCB Assembly	02-004-0845
Bessel Filter Parts List	004-0845
Butterworth Filter Schematic (.1 Hz-1.5 kHz)	03-004-0850
Butterworth Filter PCB Assembly	02-004-0850
Butterworth Filter Parts List	004-0850
Bessel Filter Schematic (.1 Hz-1.5 kHz)	03-004-0855
Bessel Filter PCB Assembly	02-004-0855
Bessel Filter Parts List	004-0855
Strain Relief Kit Parts List	002.0899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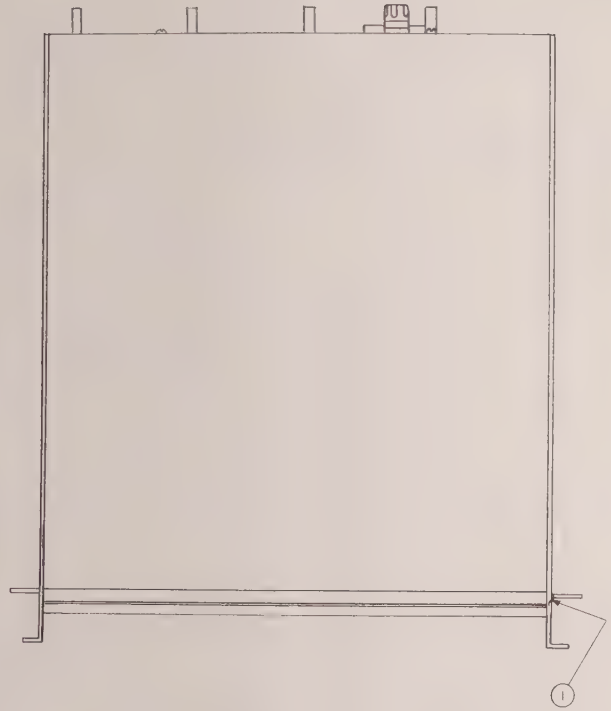
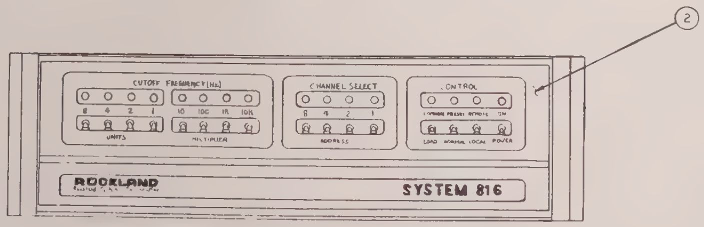
4
2 AMP
7
3
9 TYP. 6 PLACES
8 TYP. 3 PLACES




2
CUTOFF FREQUENCY (Hz)
8
4
2
1
10
100
1K
10K
UNITS
MULTIPLIER
CHANNEL SELECT
8
4
2
1
ADDRESS
CONTROL
PRESET
REMOTE
ON
LOAD
NORMAL
LOCAL
POWER
ROCKLAND
SYSTEM 816

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NONE	STRAIN RELIEF KIT 816			002.0899	1
NONE	COVER TOP, BLACK	MPV40464-26	BUKEY	304.0105	1
NONE	COVER BOTTOM, 816, BLACK	MPV40431	BUKEY	304.0207	1
NONE	CONN: PC .156 18POS DR EYE	50-36A-30	CINCH	350.3601	3
NONE	PWR CORD: 3 COND IEC, USA	17250	BELDN	378.4007	1
NONE	M SCR: ST CD PH 4-40 X 3/8 PH			381.4062	6

WAVETEK PARTS LIST
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ASSEMBLY NO. 000.0816
REV
PAGE 1

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DRAWN BY	DATE
CHECKED BY	
ENG APPVL.	
MFG APPVL.	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
XXX ±
XX ±
X/X ± 1/64
∠° ± 1°

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TITLE FILTER: ANALOG 816 (10-10K STD)

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SCALE
SHEET OF

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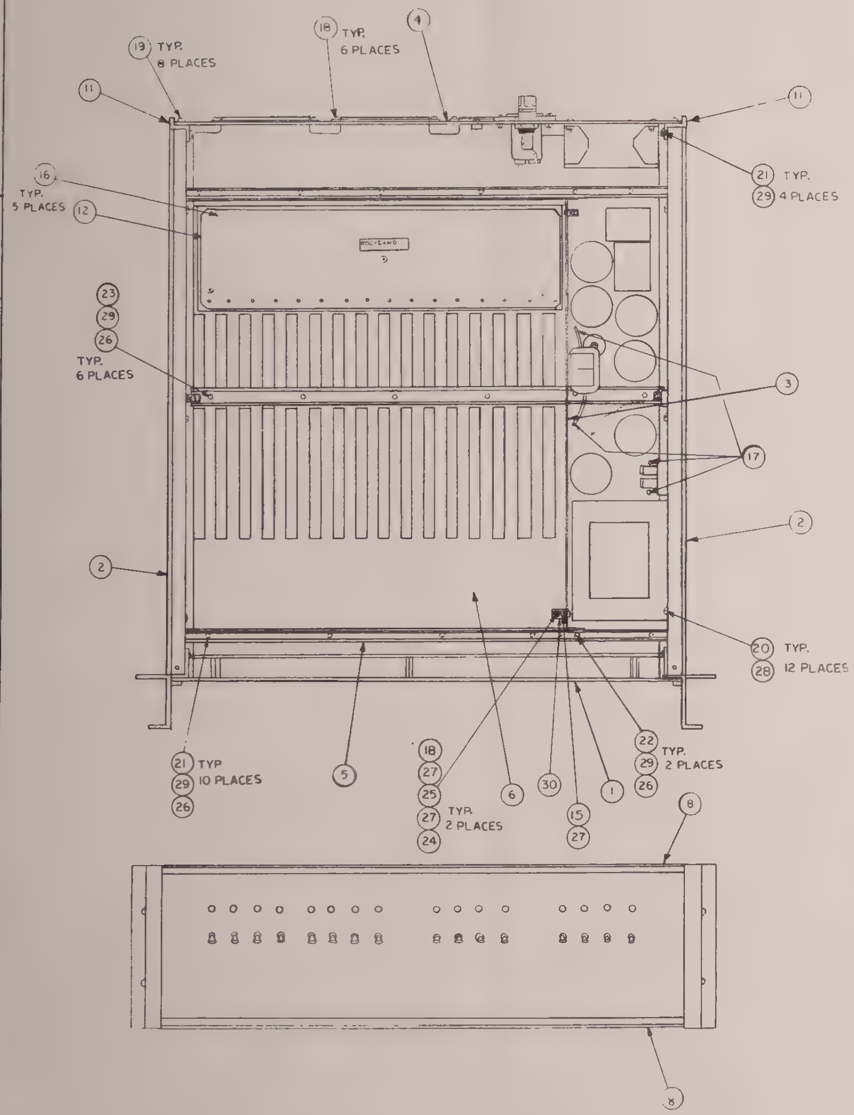
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3
17
2
2
20 TYP.
28 12 PLACES
21 TYP
29 10 PLACES
26
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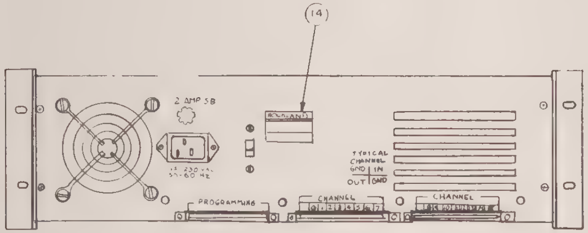
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2 AMP SB
TYPICAL CHANNEL
GND IN
OUT GND
PROGRAMMING
CHANNEL
CHANNEL

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NONE	SHIELD PLATE ASSY 816			002.0870	1
NONE	REAR PANEL ASSY 816			002 0875	1
NONE	CARD CAGE ASSY 816			002.0890	1
NONE	MAINBOARD ASSY 816			004 0820	1
NONE	TRIM: REAR	MP40281-2	BUKEY	304.0902	2
NONE	TRIM: FRONT TOP SUPR/SNUB 512	MP40318-4	BUKEY	307.0914	2
NONE	PC: SHIELD (816MB)			320 0850	1
NONE	SOCKET: INSULATED			353.0105	2
NONE	CONN: TERM PIN .025 WW (NAIL)	W98-025-560-GH-GOLD	A/S	354.0003	5
NONE	SLVNG: PLASTIC FBRGLS [redacted]			378.5181	7
NONE	M SCR: ST CD PH 4-40 X 1/4 PH			381.4042	1
NONE	M SCR: ST CD PH 4-40 X 3/8 PH			381.4062	2
NONE	M SCR: ST CD PHIL 6-32 X 1/4			381.6042	8
NONE	M SCR: ST CD PH 6-32 X 3/8 PH			381 6062	12
NONE	M SCR: ST CD PH 8-32 X 3/8 PH			381 8062	16
NONE	M SCR: ST CD PH 8-32 X 1/2 PH			381.8082	6
NONE	NUT: HX ST CD 4-40 X 1/4AF			387 4080	2
NONE	WASHER: FLAT STL CAD #4			388.0040	2
NONE	WASHER: FLAT STL CAD #8			388.0080	18
NONE	WASHER: EXT LK STL CAD #4			388.1041	5
NONE	WASHER. EXT LK STL CAD #6			388 1061	12
NONE	WASHER: EXT LK STL CAD #8			388 1081	22
NONE	BKT: ANG ST CD 1/2 X 1/2			389 3002	1

WAVETEK
PARTS LIST
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MAINFRAME ASSY 816
ASSEMBLY NO. 002.0800
REV B

SHEET 2 IS "D" SIZE
SHEET 3 IS "A" SIZE L/M

DRAWN BY	DATE
CHECKED BY	
ENG APPVL.	
MFG APPVL.	

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN
INCHES AFTER FINISHING
AND TOLERANCES ARE
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

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TITLE
MAINFRAME ASSEMBLY
816

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DRAWING NO. 02 002 0800
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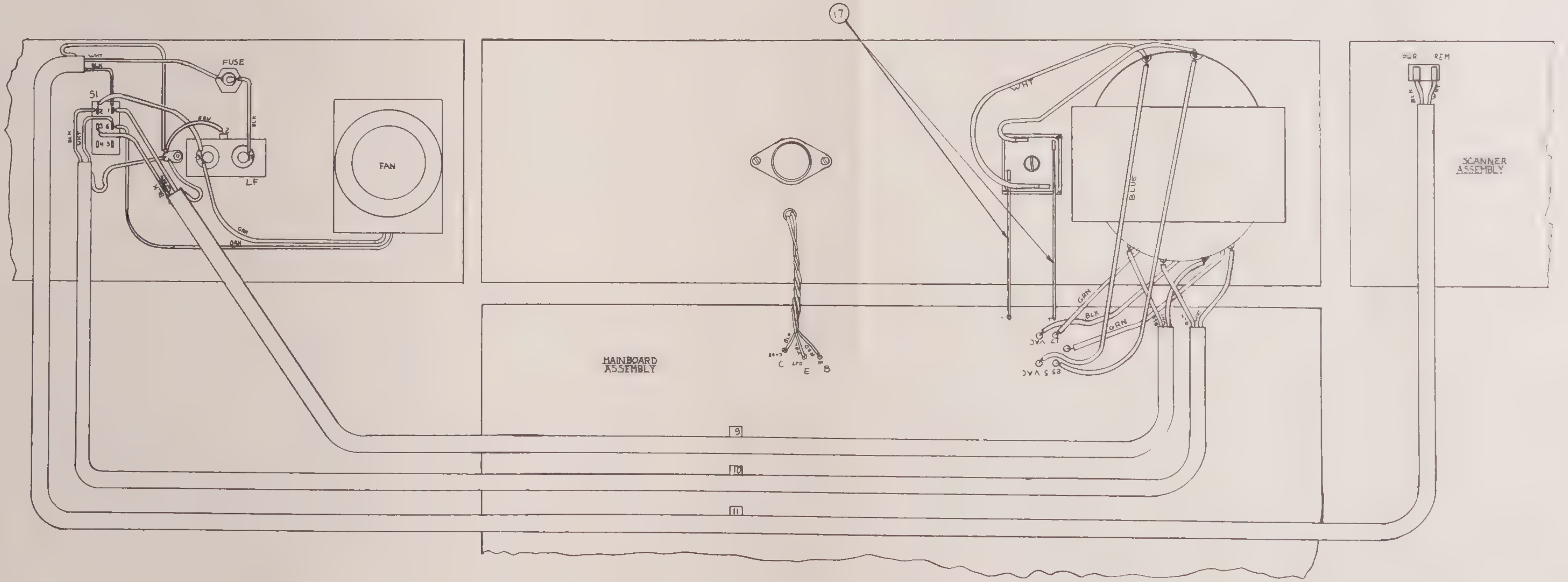

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WHT
BLK
FUSE
S1
2
1
6
4
3
BLK
WHT
GRN
2
BLK
3
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LF
FAN
GRN
GRN
BLK
MAINBOARD ASSEMBLY
BLK
CASE
C
GND
E
B
9
10
11
WHT
BLUE
GRN
BLK
GRN
17 VAC
8.5 VAC
PWR
REM
BLK
WHT
SCANNER ASSEMBLY

DRAWN BY WNT	DATE 8-9-76
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MFG APPVL. ROH	11/11/76

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UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN
INCHES AFTER FINISHING
AND TOLERANCES ARE:
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.XX ±
X/X ± 1/64
∠° ± 1°

TITLE
MAINFRAME ASSEMBLY 816

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REV B
SCALE 1:1
SHEET 2 OF 3

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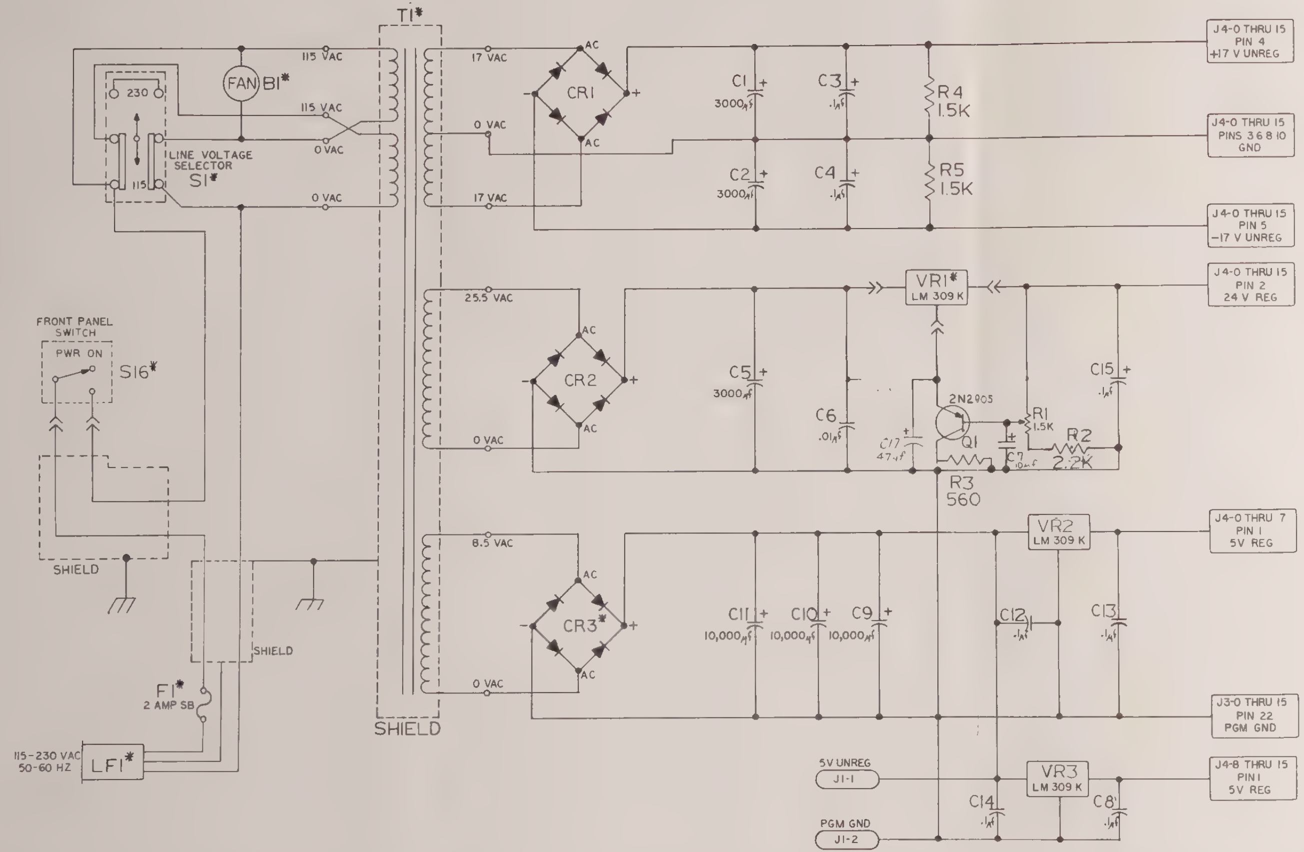
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FAN B1*
230
115 VAC
0 VAC
LINE VOLTAGE SELECTOR
S1*
115
0 VAC
17 VAC
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17 VAC
AC
CR1
AC
C1
3000μf
C3
.1μf
R4
1.5K
C2
3000μf
C4
.1μf
R5
1.5K
J4-0 THRU 15 PIN 4 +17 V UNREG
J4-0 THRU 15 PINS 3 6 8 10 GND
J4-0 THRU 15 PIN 5 −17 V UNREG
FRONT PANEL SWITCH
PWR ON
S16*
25.5 VAC
CR2
0 VAC
C5
3000μf
C6
.01μf
VR1*
LM 309 K
J4-0 THRU 15 PIN 2 24 V REG
2N2905
Q1
C17
47μf
C7
10μf
R1
1.5K
R2
2.2K
C15
.1μf
R3
560
SHIELD
8.5 VAC
CR3*
0 VAC
C11
10,000μf
C10
10,000μf
C9
10,000μf
C12
.1μf
VR2
LM 309 K
C13
.1μf
J4-0 THRU 7 PIN 1 5V REG
J3-0 THRU 15 PIN 22 PGM GND
SHIELD
F1*
2 AMP SB
SHIELD
115-230 VAC 50-60 HZ
LF1*
5V UNREG
J1-1
VR3
LM 309 K
C14
.1μf
C8
.1μf
J4-8 THRU 15 PIN 1 5V REG
PGM GND
J1-2

LOAD 0	J1-7	J3-0-4
1	J1-8	J3-1-4
2	J1-9	J3-2-4
3	J1-10	J3-3-4
4	J1-11	J3-4-4
5	J1-12	J3-5-4
6	J1-13	J3-6-4
7	J1-14	J3-7-4
8	J1-15	J3-8-4
9	J1-16	J3-9-4
10	J1-17	J3-10-4
11	J1-18	J3-11-4
12	J1-19	J3-12-4
13	J1-20	J3-13-4
14	J1-21	J3-14-4
LOAD 15	J1-22	J3-15-4

READ 0	J1-H	J3-0-3
1	J1-J	J3-1-3
2	J1-K	J3-2-3
3	J1-L	J3-3-3
4	J1-M	J3-4-3
5	J1-N	J3-5-3
6	J1-P	J3-6-3
7	J1-R	J3-7-3
8	J1-S	J3-8-3
9	J1-T	J3-9-3
10	J1-U	J3-10-3
11	J1-V	J3-11-3
12	J1-W	J3-12-3
13	J1-X	J3-13-3
14	J1-Y	J3-14-3
READ 15	J1-Z	J3-15-3

MLT 10DI	J2-M	J3-0 15-12
MLT 100 DI	J2-N	J3-0 15-11
MLT K DI	J2-P	J3-0 15-13
MLT 10K DI	J2-R	J3-0 15-10
FRQ 1DI	J2-11	J3-0 15-16
FRQ 2DI	J2-12	J3-0 15-15
FRQ 4DI	J2-13	J3-0 .15-14
FRQ 8DI	J2-14	J3-0 15-17
MLT 1K DO	J2-15	J3-0 . 15-8
MLT 10K DO	J2-16	J3-0....15-9
MLT 100 DO	J2-17	J3-0 ..15-7
MLT 10 DO	J2-18	J3-0 15-6
FRQ 8 DO	J2-22	J3-0. 15-18
FRQ 4 DO	J2-21	J3-0 15-20
FRQ 2 DO	J2-20	J3-0. 15-21
FRQ 1DO	J2-19	J3-0 15-19
PRST DI	J2-B	J3-0. 15-5

CHSEL 1	J5-1	J1-C
DEVSEL	J5-2	J1-3
CHSEL 2	J5-3	J1-D
PRESET	J5-4	J1-4
CHSEL 4	J5-5	J1-E
PARPGM	J5-6	J1-5
CHSEL 8	J5-7	J1-F
LOAD	J5-8	J1-6
LDACK	J5-9	J2-A
FRQ 1	J5-10	J2-Y
FRQ 2	J5-11	J2-Z
FRQ 4	J5-12	J2-W
FRQ 8	J5-13	J2-X
MLT 10	J5-14	J2-V
MLT 100	J5-15	J2-U
MLT 1K	J5-16	J2-S
MLT 10 K	J5-17	J2-T

OUT 0	J4-0-7	J6-C
1	J4-1-7	J6-E
2	J4-2-7	J6-H
3	J4-3-7	J6-K
4	J4-4-7	J6-M
5	J4-5-7	J6-P
6	J4-6-7	J6-S
7	J4-7-7	J6-V
8	J4-8-7	J7-C
9	J4-9-7	J7-E
10	J4-10-7	J7-H
OUT 11	J4-11-7	J7-K

OUT 12	J4-12-7	J7-M
13	J4-13-7	J7-P
14	J4-14-7	J7-S
OUT 15	J4-15-7	J7-U

GND	J4-0-8	J6-D
	J4-1-8	J6-F
	J4-2-8	J6-J
GND	J4-3-8	J6-L

GND	J4-4-8	J6-N
	J4-5-8	J6-R
	J4-6-8	J6-T
	J4-7-8	J6-V
	J4-8-8	J7-D
	J4-9-8	J7-F
	J4-10-8	J7-J
	J4-11-8	J7-L
	J4-12-8	J7-N
	J4-13-8	J7-R
	J4-14-8	J7-T
GND	J4-15-8	J7-V

IN 0	J4-0-9	J6-4
1	J4-1-9	J6-6
2	J4-2-9	J6-8
3	J4 3-9	J6-10
4	J4-4-9	J6-12
5	J4-5-9	J6-14
6	J4-6-9	J6-16
7	J4-7-9	J6-18
8	J4-8-9	J7-4
9	J4-9-9	J7-6
10	J4-10-9	J7-8
IN 11	J4-11-9	J7-10

IN 12	J4-12-9	J7-12
13	J4-13-9	J7-14
14	J4-14-9	J7-16
IN 15	J4-15-9	J7-18

GND	J4-0-10	J6 3
	J4-1-10	J6-5
	J4-2-10	J6-7
GND	J4-3-10	J6-9

GND	J4-4-10	J6-11
	J4-5-10	J6-13
	J4-6-10	J6-15
	J4-7-10	J6-17
	J4-8-10	J7-3
	J4-9-10	J7-5
	J4-10-10	J7-7
	J4-11-10	J7-9
	J4-12 10	J7 11
	J4-13-10	J7-13
	J4-14 10	J7-15
GND	J4-15-10	J7-17

NOTES:

* 1. S1, B1, FL1, AND F1 ARE MOUNTED ON REAR PANEL ASSY.
T1, VR1, AND CR3, ARE MOUNTED ON RIGHT SIDE PANEL ASSY.
S16 IS MOUNTED ON FRONT PANEL SCANNER ASSY.

2. ALL RESISTOR VALUES ARE IN OHMS.

TOLERANCES (EXCEPT AS NOTED)	**ROCKLAND** ROCKLAND SYSTEMS CORP		
DECIMAL .XXX .010 .XX .02		SCALE	DRAWN BY [illegible] APPROVED BY [illegible]
FRACTIONAL ± 1/64	TITLE SCHEMATIC MAINBOARD 816		
ANGULAR ±	DATE	DRAWING NUMBER 23 - [illegible]	REV [illegible]

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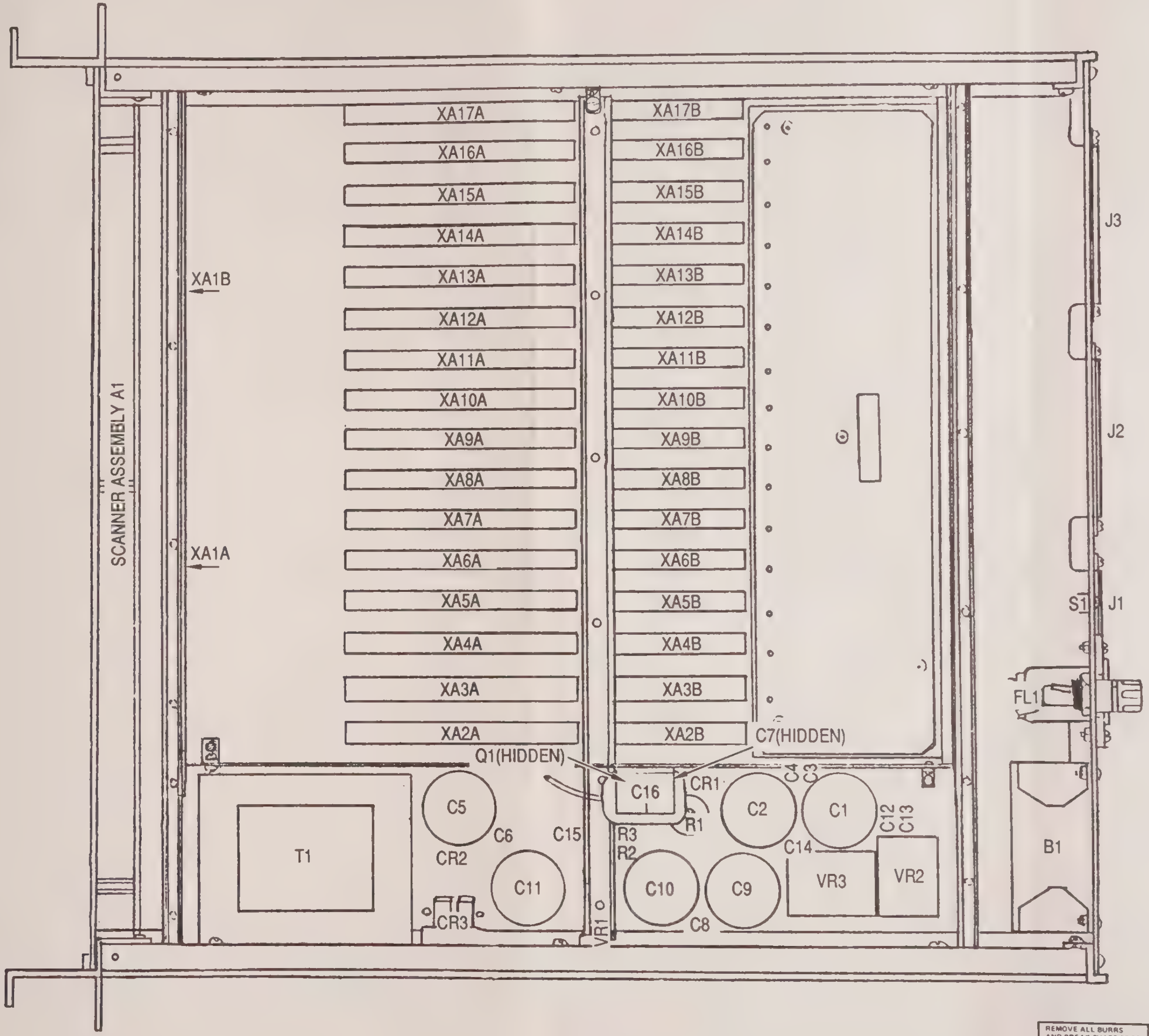
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XA4A
XA3A
XA2A
XA17B
XA16B
XA15B
XA14B
XA13B
XA12B
XA11B
XA10B
XA9B
XA8B
XA7B
XA6B
XA5B
XA4B
XA3B
XA2B
XA1B
XA1A
SCANNER ASSEMBLY A1
J3
J2
S1
J1
FL1
B1
Q1(HIDDEN)
C7(HIDDEN)
C16
CR1
R1
C4
C3
C5
C6
C15
T1
CR2
C11
CR3
VR1
R3
R2
C10
C9
C8
C2
C1
C12
C13
C14
VR3
VR2

MADE FROM 02-002-0800B

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE MAINFRAME ASSY
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG		MODEL NO 816
	SCALE		DWG NO 004 0820
			REV
			CODE 23338
			SHEET OF

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C6	C: FX CER .01UF GMV 1KV	DD-103	CRL	100 3100	1
C12 C13 C14 C8	C: FX CER .1UF +80 -20% 16V	XXUK16-104	CRL	100. 4101	4
C15 C3 C4	C: FX TANT .10UF 20% 35V	T368A104M035A$	KEMET	109. 4100	3
C7	C: FX TANT 10UF 20% 20V	T368B106M025A$	KEMET	109. 6100	1
C17	C: FX ELECT 47UF 20% 63V	B41283	SIECO	109. 6470	1
C1 C2 C5	C: FX ELECT 3000UF 50V (PC)	3487AE332M050KM	MEPCO	109. 8300	3
C10 C11 C9	C: FX ELECT 10000UF 15V (PC)	3487BD103M016KM	MEPCO	109. 9100	3
R3	R: FX COMP 560 OHM 5% 1/2W			116. 1562	1
R4 R5	R: FX COMP 1.5K OHM 5% 1/2W			116 2152	2
R2	R: FX CFLM 2.2K OHM 5% 1/4W			116 2221	1
R1	R: VAR WW 1.5K 3/4" RND PC	B091626	CTS	118. 2154	1

WAVETEK PARTS LIST
TITLE MAINBOARD ASSY 816
ASSEMBLY NO. 004. 0820
REV K
PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
VR2 VR3	Q: P.V. REG 5V 5% 1A TO-3	LM309K STEEL	SCHEL	120. 0051	2
NONE	PC: MAINBOARD (816)			320. 0820	1
CR1	SIL FWB 50PIV 1.5A	PF-05	EDI	130. 0140	1
CR2	SIL FWB 100PIV 5A			130 1440	1
Q1	Q: SIL PNP (2N2905A)			136 2905	1
NONE	SPACER: SWITCH NYLON 1/16"	FW4-062	MICRO	349. 2010	3
NONE	CONN: PC .156 10POS SR ST	50-10B-10	CINCH	350. 1002	16
NONE	CONN: PC .156 22POS SR ST	50-22B-10	CINCH	350. 2202	16
J1 J2	CONN: PC .156 22POS DR ST	50-44B-10	CINCH	350. 4401	2
NONE	HEAT SINK: TO-3 U 234H	61048	THERM	367 0403	2
NONE	SPACER: TXSTR LEAD, NYL, LOW			376. 2108	1
NONE	M SCR: ST CD PH 4-40 X 3/8 PH			381. 4062	3
NONE	M SCR: ST CD PH 4-40			381 4082	4

WAVETEK PARTS LIST
TITLE MAINBOARD ASSY 816
ASSEMBLY NO. 004. 0820
REV K
PAGE 2

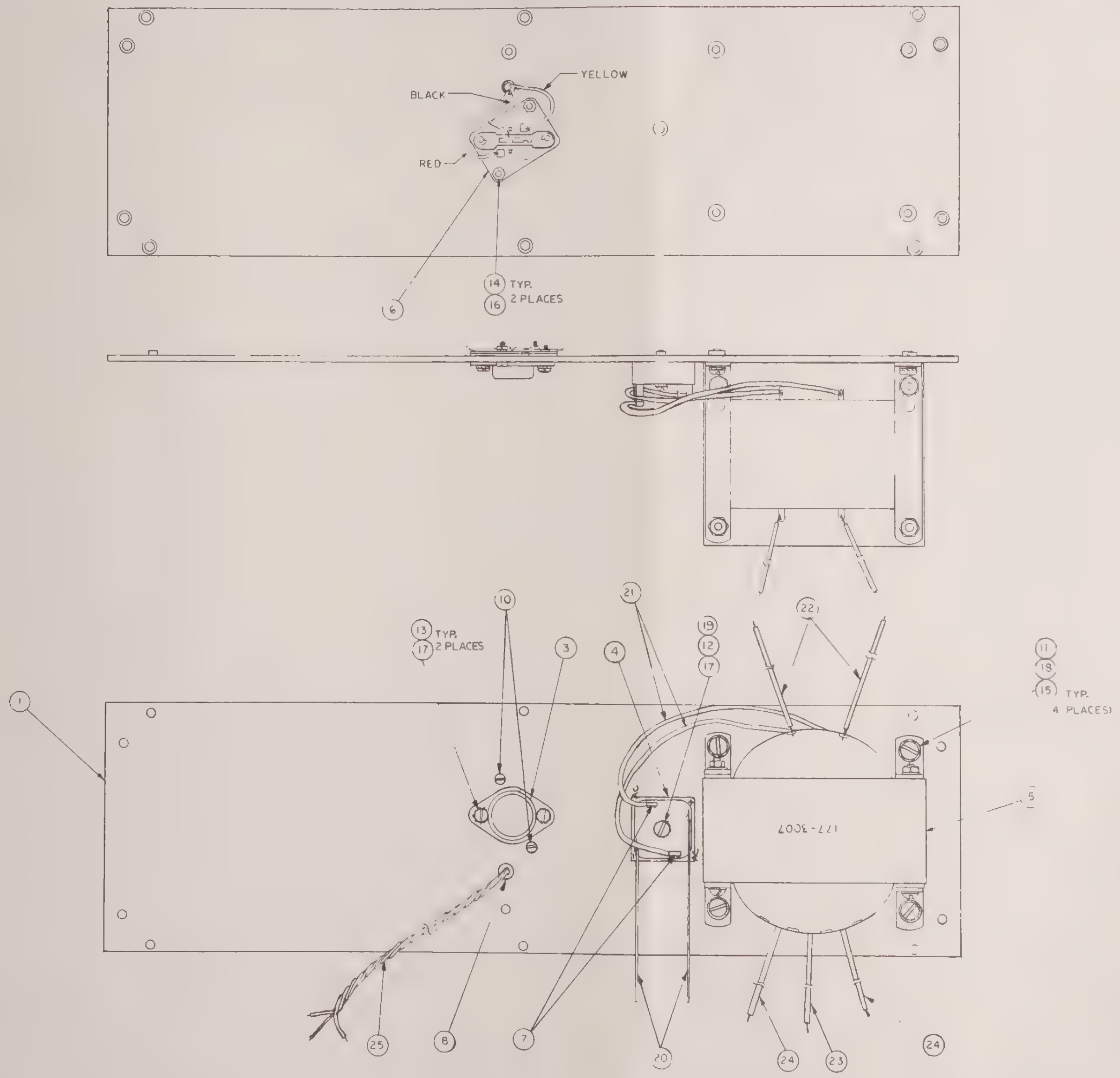
REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
	X 1/2 PH				
NONE	NUT: HX ST CD 4-40 X 1/4AF			387. 4080	7
NONE	WASHER FLAT STL CAD #4			388 0040	3
NONE	WASHER INT LK STL CAD #4			388 1040	11

WAVETEK PARTS LIST
TITLE MAINBOARD ASSY 816
ASSEMBLY NO. 004. 0820
REV K
PAGE 3

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN
DATE
PROJ ENGR
REL FOR APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX ± .010 ANGLES ± 1
XX ± .030
DO NOT SCALE DWG
SCALE
WAVETEK SAN DIEGO • CALIFORNIA
TITLE
PARTS LIST
MAINBOARD ASSY
MODEL NO 816
DWG NO 004 0820
REV K
CODE IDENT 23338
SHEET 1 OF 1

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	611	WNT	[illegible] SLH	[illegible]
B	1812	10.21.86	[illegible]	[illegible]



YELLOW
BLACK
RED
6
14 TYP.
16 2 PLACES
13 TYP.
17 2 PLACES
10
3
4
21
19
12
17
22
11
18
15 TYP.
4 PLACES)
1
5
177-3007
25
8
7
20
24
23
24

NOTES:

1) FILE (AS REQUIRED) 4 LEGS OF ITEM 5 TO INSURE GOOD METAL-TO-METAL CONTACT

SHEET 2 IS "A" SIZE L/M

DRAWN BY WNT
DATE 7/1/86
CHECKED BY
ENG APPVL
MFG APPVL SLH

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

ROCKLAND
Rockland Systems Corporation

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TITLE
SIDE PLATE ASSEMBLY
316

SIZE D
DRAWING NO. 02 002-0360
REV B
SCALE 1/1
SHEET 1 OF 2

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
4	SIL FWB 50PIV 12A			130 0541	1
5	XFMR PWR DUAL PRI			177 3007	1
1	SIDE PLATE RIGHT 816			304 0909	1
6	SOCKET. I.C TO-3	4610	KEYST	353 0301	1
7	LUG CRIMP FEM SNAP DISCON	814-250A	T&B	359 0003	2
8	SNAP BUSHING 1/4" PLASTIC BLK			367 1103	1
26	INSULATOR MICA TO-3			368 5003	1
20	WIRE BUSS TINNED #18 AWG			378 0400	10
21	WIRE #14 AWG STR WHITE			378 1294	14
22	WIRE #18 AWG STR BLUE			378 1464	14
23	WIRE #24 AWG BON BLACK			378 1705	6
24	WIRE #24 AWG BON GREEN			378 1755	12
25	CABLE TW 3 COND RED/YEL/BLK	3154	ALPHA	378 4004	7

WAVETEK
PARTS LIST
TITLE SIDE PLATE ASSY 816
ASSEMBLY NO 002 0860
REV B
PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
10	M SCR ST CD SL 4-40 X 3/8PH			380 4062	2
11	M SCR ST CD SL 8-32 X 3/8PH			380 8062	4
NONE	M SCR· ST CD 6-32 X 3/4 PH			381 6122	1
13	M SCR ST CD SL 6 X 1/2 8PH			386. 6080	2
14	NUT HX ST CD 4-40 X 1/4AF			387 4080	2
19	WASHER FLAT STL CAD [illegible]			388 0060	1
15	WASHER FLAT STL CAD #8			388 0080	4
16	WASHER EXT LK STL CAD #4			388 1041	2
17	WASHER EXT LK STL CAD #6			388 1061	3
18	WASHER EXT LK STL CAD #8			388 1081	4
VR1	VOLTAGE REGULATOR, 3 A. 5V+	LM323K	NSC	7000-03-2300	1

WAVETEK
PARTS LIST
TITLE SIDE PLATE ASSY 816
ASSEMBLY NO 002 0860
REV B
PAGE 2

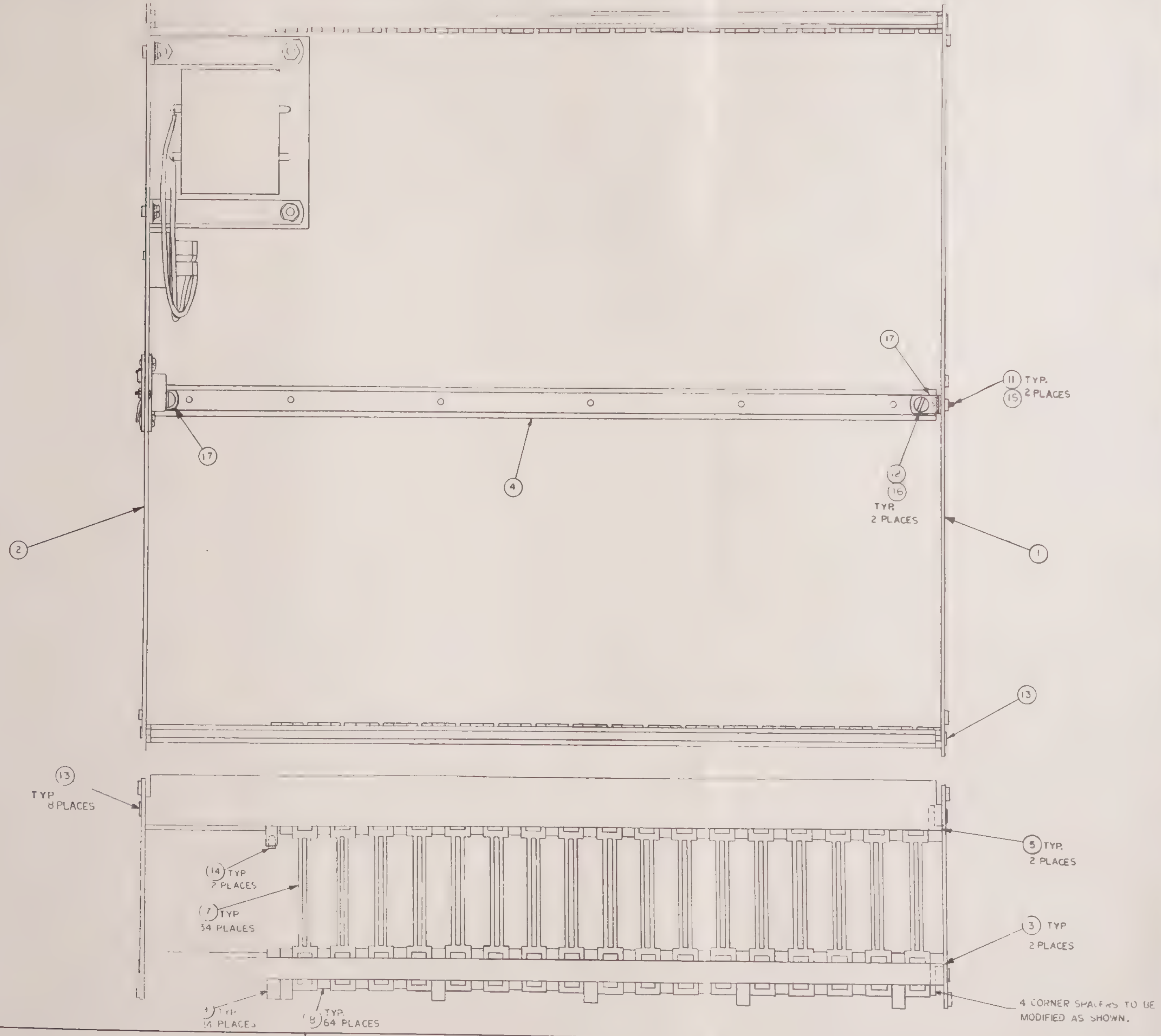
NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH
WAVETEK PROCESS
DRAWN
DATE
PROJ ENGR
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX ± .010 ANGLES ± 1
XX ± .030
DO NOT SCALE DWG
SCALE

WAVETEK SAN DIEGO • CALIFORNIA
TITLE
PARTS LIST
SIDE PLATE ASSEMBLY
MODEL NO 816
DWG NO 002.0860
REV B
CODE IDENT 23338
SHEET 1 OF 1

BISHOP GRAPHICS ACCUPRESS
REORDER NO. A27086

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE



17
11 TYP.
15 2 PLACES
17
4
12
16
TYP.
2 PLACES
2
1
13
13
TYP
8 PLACES
5 TYP.
2 PLACES
14 TYP
2 PLACES
7 TYP
34 PLACES
3 TYP
2 PLACES
TYP
14 PLACES
8 TYP.
64 PLACES
4 CORNER SPACERS TO BE
MODIFIED AS SHOWN.

SHEET 2 IS "A" SIZE L/M

DRAWN BY
N T
DATE
CHECKED BY
ENG APPVL
MFG APPVL

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN
INCHES AFTER FINISHING
AND TOLERANCES ARE
XXX ±
XX ±
X/X ± 1/64
∠° ± 1°

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TITLE
CARD CAGE ASSEMBLY
816

SIZE D
DRAWING NO. 02 002 0890
REV A
SCALE 1:1
SHEET 1 OF 2

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	SIL FWB 50PIV 12A			130 0541	1
NONE	XFMR PWR DUAL PRI			177 3007	1
NONE	SIDE PLATE RIGHT 816			304 0909	1
NONE	SOCKET I.C TO-3	4610	KEYST	353 0301	1
NONE	LUG CRIMP FEM SNAP DISCON	B14-250A	T&B	359.0003	1
NONE	SNAP BUSHING· 1/4" PLASTIC BLK			367 1103	1
NONE	INSULATOR MICA TO-3			368 5003	1
NONE	WIRE BUSS TINNED #18 AWG			378 0400	1
NONE	WIRE· #14 AWG STR WHITE			378 1294	1
NONE	WIRE #18 AWG STR BLUE			378 1464	1
NONE	WIRE· #24 AWG BON BLACK			378 1705	1
NONE	WIRE. #24 AWG BON [illegible]			378 1755	1
NONE	CABLE· TW 3 COND RED/YEL/BLK	3154	ALPHA	378 4004	1

WAVETEK PARTS LIST	TITLE CARD CAGE ASSY 816	ASSEMBLY NO 002 0890 PAGE 1	REV A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	M SCR· ST CD SL 4-40 X 3/8PH			380 4062	1
NONE	M SCR: ST CD SL 8-32 X 3/8PH			380 8062	1
NONE	M SCR: ST CD 6-32 X 3/4 PH			381 6122	1
NONE	M SCR: ST CD SL 6 X 1/2 BPH			386 6080	1
NONE	NUT· HX ST CD 4-40 X 1/4AF			387 4080	1
NONE	WASHER, FLAT STL CAD #6			388 0060	1
NONE	WASHER, FLAT STL CAD #8			388 0080	1
NONE	WASHER, EXT LK STL CAD #4			388 1041	1
NONE	WASHER, EXT LK STL CAD #6			388 1061	1
NONE	WASHER EXT LK STL CAD #8			388 1081	1
NONE	VOLTAGE REGULATOR, 3 A, 5V+	LM323K	NSC	7000-03-2300	1

WAVETEK PARTS LIST	TITLE CARD CAGE ASSY 816	ASSEMBLY NO. 002 0890 PAGE 2	REV A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	EXT CARD GUIDE 816	05 002 0880	SCANB	002 0880	2
NONE	EXT MAINBOARD SUPPORT 816	05 002 0885	SCANB	002 0885	1
NONE	EXT CARD GUIDE MT TOP 816	05 002 0895	SCANB	002 0895	2
NONE	SIDE PLATE LEFT 816			304 0908	1
NONE	CARD GUIDE, NYLON, WHT (816)	T-309-39	SCANB	362 0611	34
NONE	SPACER CARD GUIDE 250 (816)	T-101-250	SCANB	362 0612	64
NONE	SPACER STOP CARD GUIDE	T-910	SCANB	362 0613	14
NONE	M SCR· ST CD SL 6-32 X 3/8BH			380 6061	2
NONE	M SCR. ST CD SL 8-32 X 3/8PH			380 8062	2
NONE	SKT ST SCR ST CD 8-32X1/4CP			386 8040	2
NONE	SKT CSCR BLK 8-32X1/2 82FH			386.8081	8
NONE	WASHER. EXT LK STL			388 1061	2

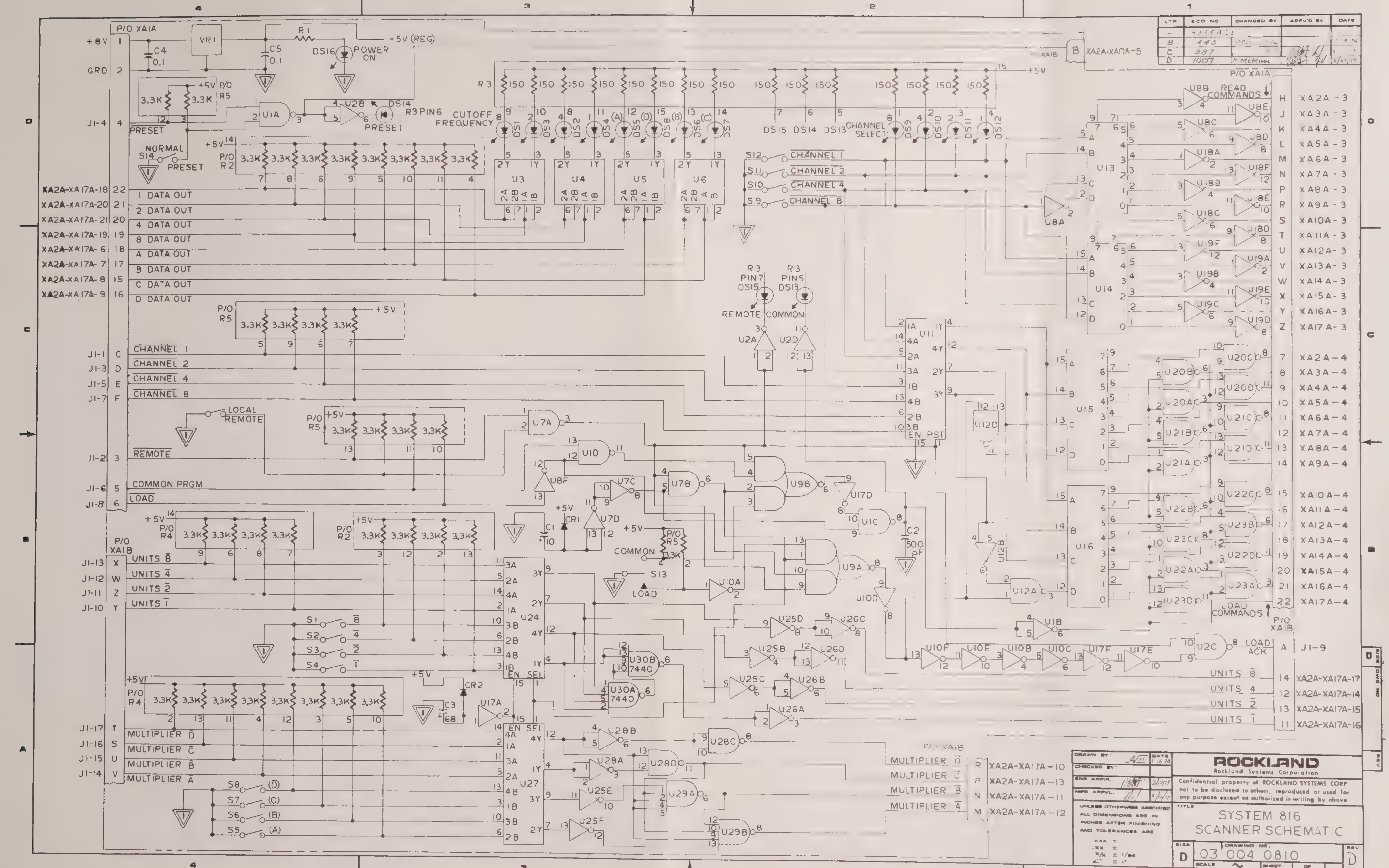
WAVETEK PARTS LIST	TITLE CARD CAGE ASSY 816	ASSEMBLY NO 002 0890 PAGE 3	REV A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
	CAD #6				
NONE	WASHER EXT LK STL CAD #8			388 1081	2
NONE	BKT ANG ST CD 628 X [illegible]	618	KEYST	389 3004	2

WAVETEK PARTS LIST	TITLE CARD CAGE ASSY 816	ASSEMBLY NO 002 0890 PAGE 4	REV A

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE PARTS LIST CARD CAGE ASSY
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX · 010 ANGLES · 1 XX 030		
	DO NOT SCALE DWG		MODEL NO 816
	SCALE		DWG NO 002 0890
			REV A
			CODE IDENT 23338
			SHEET OF 1


P/O XA1A
+8V
GRD
J1-4
PRESET
VR1
C4 0.1
C5 0.1
R1
+5V (REG)
DS16 POWER ON
U1A
U2B
DS14
R3 PIN6
PRESET
NORMAL
S14
R3 150
CUTOFF FREQUENCY
DS1 DS3 DS2 DS4 DS5 DS8 DS6 DS7
(A) (D) (B) (C)
DS15 DS14 DS13
CHANNEL SELECT
DS9 DS10 DS11 DS12
+5V
P/O R2 3.3K
U3 U4 U5 U6
XA2A-XA17A-18 22 1 DATA OUT
XA2A-XA17A-20 21 2 DATA OUT
XA2A-XA17A-21 20 4 DATA OUT
XA2A-XA17A-19 19 8 DATA OUT
XA2A-XA17A-6 18 A DATA OUT
XA2A-XA17A-7 17 B DATA OUT
XA2A-XA17A-8 15 C DATA OUT
XA2A-XA17A-9 16 D DATA OUT
P/O R5 3.3K
J1-1 C CHANNEL 1
J1-3 D CHANNEL 2
J1-5 E CHANNEL 4
J1-7 F CHANNEL 8
LOCAL REMOTE
J1-2 3 REMOTE
J1-6 5 COMMON PRGM
J1-8 6 LOAD
S12 CHANNEL 1
S11 CHANNEL 2
S10 CHANNEL 4
S9 CHANNEL 8
R3 PIN7 DS15 REMOTE
R3 PIN5 DS13 COMMON
U2A U2D
U11 EN PST
U7A U1D U8F U7C U7B U9B U17D U1C U7D U9A U10A U10D
C1 10 CR1
C2 500 PF
COMMON P/O R5 3.3K
S13 LOAD
P/O XA1B
P/O R4 3.3K
J1-13 X UNITS 8
J1-12 W UNITS 4
J1-11 Z UNITS 2
J1-10 Y UNITS 1
S1 8 S2 4 S3 2 S4 1
U24 EN SEL
U30B 7440 U30A 7440
U25D U26C U25B U26D U25C U26B U26A
CR2 C3 68 U17A
J1-17 T MULTIPLIER D
J1-16 S MULTIPLIER C
J1-15 U MULTIPLIER B
J1-14 V MULTIPLIER A
S8 (D) S7 (C) S6 (B) S5 (A)
U27 EN SEL
U28B U28A U25E U25F U28C U28D U29A U29B
P/O XA1B
MULTIPLIER D R XA2A-XA17A-10
MULTIPLIER C P XA2A-XA17A-13
MULTIPLIER B N XA2A-XA17A-11
MULTIPLIER A M XA2A-XA17A-12
XA1B B XA2A-XA17A-5
P/O XA1A
U8B READ COMMANDS
U13 U14 U8A U8C U8D U8E U18A U18B U18C U18D U18E U18F U19A U19B U19C U19D U19E U19F
H XA2A-3
J XA3A-3
K XA4A-3
L XA5A-3
M XA6A-3
N XA7A-3
P XA8A-3
R XA9A-3
S XA10A-3
T XA11A-3
U XA12A-3
V XA13A-3
W XA14A-3
X XA15A-3
Y XA16A-3
Z XA17A-3
U15 U16 U12D U12B U12A
U20A U20B U20C U20D U21A U21B U21C U21D U22A U22B U22C U22D U23A U23B U23C U23D
7 XA2A-4
8 XA3A-4
9 XA4A-4
10 XA5A-4
11 XA6A-4
12 XA7A-4
13 XA8A-4
14 XA9A-4
15 XA10A-4
16 XA11A-4
17 XA12A-4
18 XA13A-4
19 XA14A-4
20 XA15A-4
21 XA16A-4
22 XA17A-4
LOAD COMMANDS
U1B U10F U10E U10B U10C U17F U17E U2C
LOAD ACK
P/O XA1B A J1-9
UNITS 8 14 XA2A-XA17A-17
UNITS 4 12 XA2A-XA17A-14
UNITS 2 13 XA2A-XA17A-15
UNITS 1 11 XA2A-XA17A-16
4 3 2 1
A B C D

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
–	RELEASE			
B	445	[illegible]		[illegible]
C	887		[illegible]	[illegible]
D	1007	M McMINN	[illegible]	2/27/79

DRAWN BY: | DATE 1 16 76
CHECKED BY:
ENG APPVL. | 2/10/76
MFG APPVL. | 2/14/76

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.XXX ±
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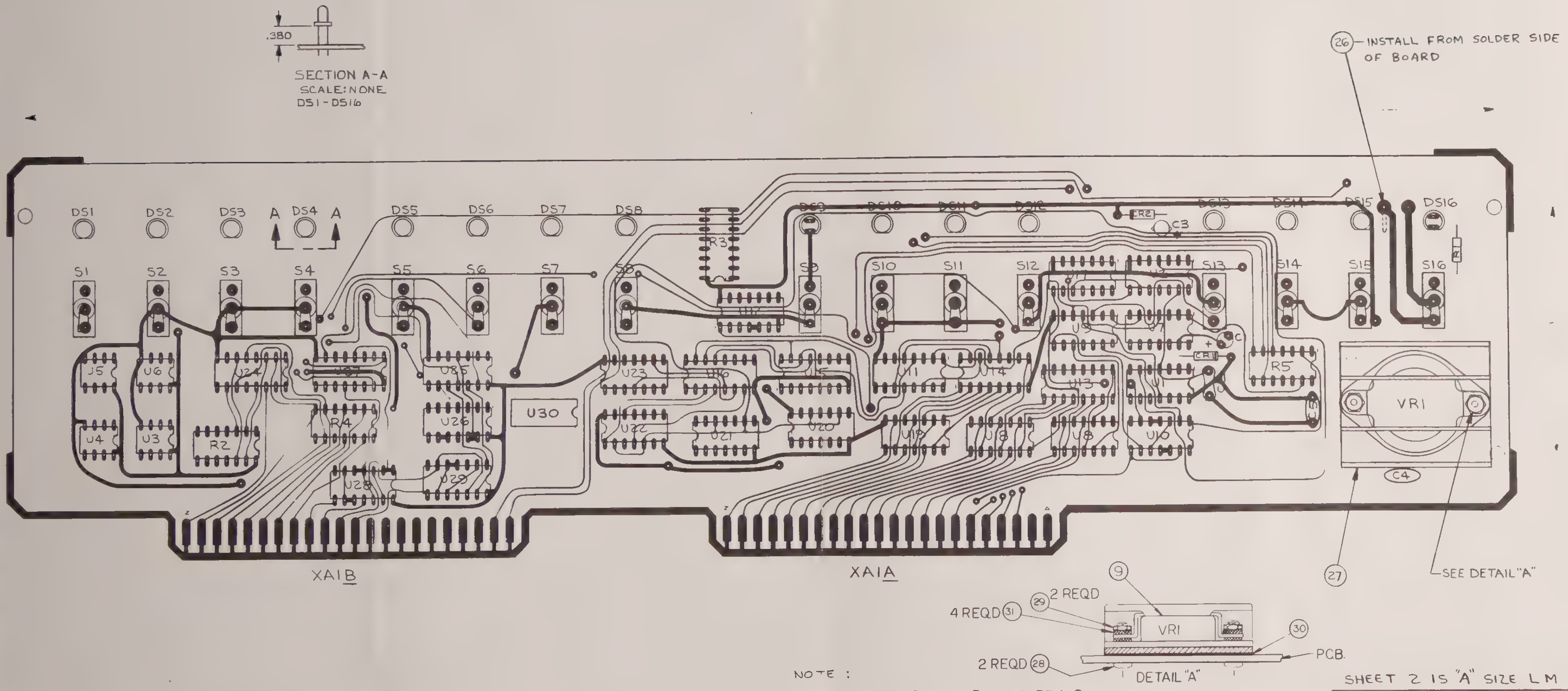
TITLE
SYSTEM 816
SCANNER SCHEMATIC

SIZE D | DRAWING NO. 03 004 0810 | REV D
SCALE ~ | SHEET | OF

LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
C	446	Paul 3/76	[illegible]	3/76
D	478		[illegible]	1/2/76
E	1007	M.McMinn	[illegible]	2/27/79
F	7869	SD 1 BJ	RBG	1/21/87



.380
SECTION A-A
SCALE: NONE
DS1-DS16
DS1
DS2
DS3
A
DS4
A
DS5
DS6
DS7
DS8
DS9
DS10
DS11
DS12
DS13
DS14
DS15
DS16
R3
CR2
C3
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
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S13
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S15
S16
U2
U5
U6
U24
U27
U25
U23
U16
U15
U11
U14
U9
U7
U13
U1
R5
CR1
C
VR1
U4
U3
R2
R4
U26
U30
U22
U21
U20
U19
U18
U8
U10
U28
U29
C4
Z
A
XA1B
XA1A
26
INSTALL FROM SOLDER SIDE OF BOARD
27
SEE DETAIL "A"
9
2 REQD
29
4 REQD
31
VR1
30
PCB.
2 REQD
28
DETAIL "A"

NOTE :

1. FOR ARTWORK LOWER THAN REV C OMIT U30.

SHEET 2 IS "A" SIZE LM

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ENG APPVL.	3/76	
MFG APPVL.	3-76	

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INCHES AFTER FINISHING
AND TOLERANCES ARE
.XXX ±
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X/X ± 1/64
∠° ± 1°

TITLE
ASSEMBLY
SCANNER - 816

SIZE D
DRAWING NO 02 004-0810
REV F
SCALE 2:1
SHEET 1 OF 2

REV	ECN	BY	DATE	APP

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
VR1	Q. P V REG 5V 5% 1A TO-3	LM309K STEEL	SCHEL	120 0051	1
NONE	C FX MONO 0 1UF 50V Z5U	SR215E104ZAT	AVX	100 4102	1
NONE	CAP.FX VAL.DIP MICA 500PF 5% 0 TO+70PPM/C 500V	CD15FD501J03	CDE	101 1500	1
NONE	C: FX TANT 10UF 20% 20V	T368B106M025AS	KEMET	109 6100	1
NONE	C· FX TANT 68UF 20% 6V	T368B686M006AS	KEMET	109 6680	1
NONE	R: FX CFLM 150 OHM 5% 1/4W			116 1151	1
NONE	U DUAL PRPHL DRIVER (75451)	SN75451BN/P3	TI	120 4451	1
NONE	ASSY, PC BD PREPPED 816-0810	816-2686	WVTK	1208-00-2686	1
NONE	U QUAD 2 IN MPLX (74157)	N74157N/S2B	SIG	122 0112	1
NONE	U· QUAD 2 IN NAND GATE	SN7400N/P3	TI	122 7400	1
NONE	U. HEX INVERTER	7404N/P3	NSC	122 7404	1

WAVETEK PARTS LIST
TITLE SCANNER ASSY 816
ASSEMBLY NO 004 0810
REV F
PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	U. QUAD 2 IN NAND BUFFER			122 7437	1
NONE	U. QD 2 IN NAND BUFFER O/C	N7438N/S2B	SIG	122 7438	1
NONE	U: DUAL 4 IN NAND BUFFER	N7440N/S2B	SIG	122 7440	1
NONE	U. BCD TO DECIMAL DECODER	N7442N/S2B	SIG	122 7442	1
NONE	U: DUAL 2 IN 2W AOI GATE	N7451N/P3	TI	122 7451	1
NONE	U: PULL UP NET 150 OHM 2% X15			128 1151	1
NONE	U: PULL UP NET 3 3K 2% X13	4114R-002-332	BOURN	128 2330	1
NONE	SL LW LK 70PIV 200MW (1N457)			132 0457	1
DS1 DS10 DS11 DS12 DS13 DS14 DS15 DS16 DS2 DS3 DS4 DS5 DS6 DS7 DS8 DS9	LED: RED, 2MCD@10, 40DVA	MV5054-1	MONSO	171 1600	16
S1 S10 S11 S12 S14 S15 S16 S2 S3 S4 S5 S6 S7 S8 S9	S: TOG SPDT ON-ON PC SFB	7101-P3-YCB	C&K	340 1202	15
S13	S TOG SPDT ON-OFF-MOM PC SFB	7107-P3-YCB	C&K	340 1203	1

WAVETEK PARTS LIST
TITLE SCANNER ASSY 816
ASSEMBLY NO 004 0810
REV F
PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	PLUG. RIGHT ANGLE			352 0102	2
NONE	HEAT SINK TO-3 U 234H	6104B	THERM	367 0403	1
NONE	M SCR ST CD PH 4-40 X 1/2 PH			381 4082	2
NONE	NUT HX ST CD 4-40 X 1/4AF			387 4080	2
NONE	WASHER EXT LK STL CAD #4			388 1041	4

WAVETEK PARTS LIST
TITLE SCANNER ASSY 816
ASSEMBLY NO 004 0810
REV F
PAGE 3

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
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FINISH WAVETEK PROCESS
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PROJ ENGR
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX · 010 ANGLES · 1
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DO NOT SCALE DWG
SCALE

WAVETEK SAN DIEGO • CALIFORNIA
TITLE
PARTS LIST
SCANNER ASSEMBLY
MODEL 816
DWG NO 004 0810
REV F
CODE IDENT 23338
SHEET 1 OF 1

REV	ECN	BY	DATE	APP
A	RELEASE			
B	[illegible]	[illegible]		
C	7894	[illegible]	[illegible]	[illegible]

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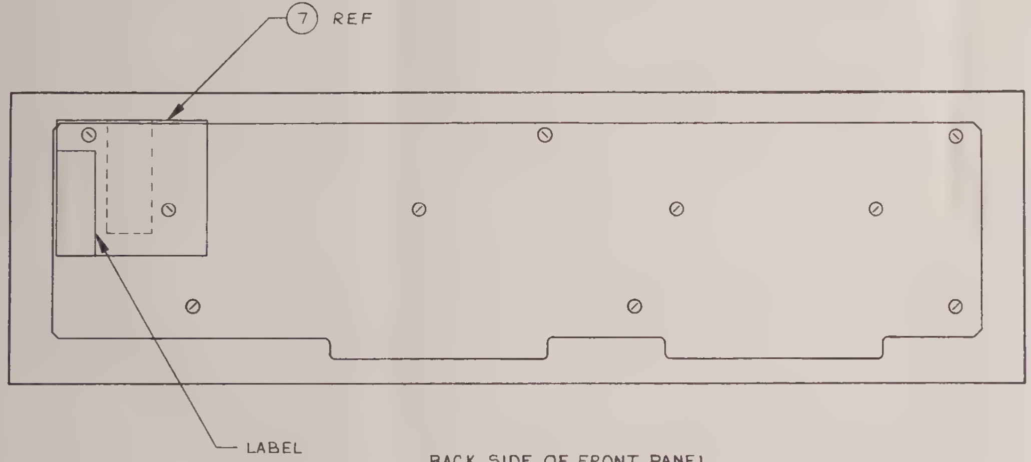
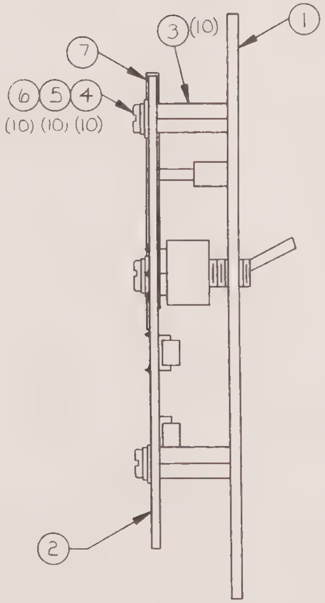


BACK SIDE OF FRONT PANEL



SCALE 2:1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
2	Q: P.V. REG 5V 5% 1A TO-3	LM309K STEEL	SCHEL	120.0031	1
2	ASSY, PRE WAVE LOAD 816-0800	816-2685	WVTK	1208-00-2685	1
2	LED, RED, 2MCD@10, 40DVA	MV5054-1	MONSD	171 1600	1
2	S: TOG SPDT ON-ON PC SFB	7101-P3-YCB	C&K	340 1202	1
2	S: TOG SPDT ON-OFF-MOM PC SFB	7107-P3-YCB	C&K	340.1203	1
2	PLUG: RIGHT ANGLE			352 0102	1
2	HEAT SINK TO-3 U .234H	61048	THERM	367 0403	1
2	M SCR. ST CD PH 4-40 X 1/2 PH			381 4082	1
2	NUT: HX ST CD 4-40 X 1/4AF			387 4080	1
2	WASHER EXT LK STL CAD #4			388 1041	1
7	SHIELD, LINE VOLTAGE PROTECTION	1400-02-2410	WVTK	1400-02-2410	1
1	FRONT PANEL: 816			300.0801	1

WAVETEK PARTS LIST
TITLE PANEL ASSEMBLY FRONT 816
ASSEMBLY NO 001.0800
REV C
PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	LABEL: CAUTION, 1488A			371.1012	1
6	M SCR: ST CD SL 4-40 X 1/4BH			380 4041	10
4	WASHER FLAT STL CAD #4			388 0040	10
5	WASHER EXT LK STL CAD #4			388 1041	10
3	SPR: THD 1/4HX 4-40X5/8	8835	SMITH	389.2006	10

WAVETEK PARTS LIST
TITLE PANEL ASSEMBLY FRONT 816
ASSEMBLY NO. 001.0800
REV C
PAGE 2

NOTE UNLESS OTHERWISE SPECIFIED

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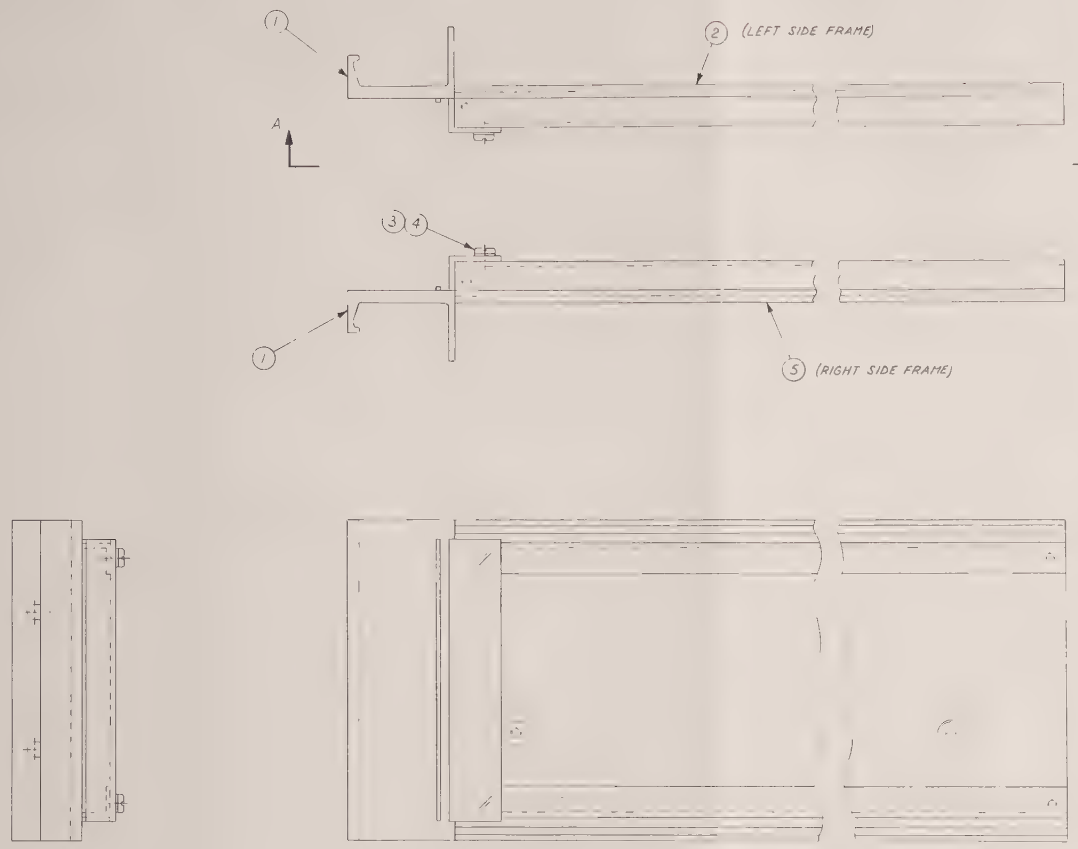
MATERIAL N/A
FINISH WAVETEK PROCESS N/A
DRAWN DATE 4/18/74
PROJ ENGR 11/11/76
RELEASE APPROV KLH 11-11-76
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX ±.010 ANGLES ±1
XX ±.030
DO NOT SCALE DWG
SCALE 1:1
WAVETEK SAN DIEGO • CALIFORNIA
TITLE SYSTEM 816 FRONT PANEL ASSEMBLY
MODEL NO 816
DWG NO 02-001-0800
REV C
CODE IDENT 23338
SHEET 1 OF 1

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	RELEASE		LHH	5/5 78



VIEW A-A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	ADAPTOR RACK MOUNTING	MP40110-2	BUKEY	304 0400	2
NONE	SIDE FRAME 816	MP40423	BUKEY	304 0501	2
NONE	M SCR BT CD SL 8-32 X 3/8PH			380 8062	4
NONE	WASHER EXT LK STL CAD #8			388 1081	4

WAVETEK PARTS LIST

TITLE SIDE FRAME ASSY 816

ASSEMBLY NO 002 0865

REV A

PAGE 1

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ENG APPVL LHH	5/5/78
MFG APPVL	

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X/X ± 1/64
∠° ± 1°

TITLE SIDE FRAME ASSEMBLIES
S.D.

SIZE D

DRAWING NO. [illegible]

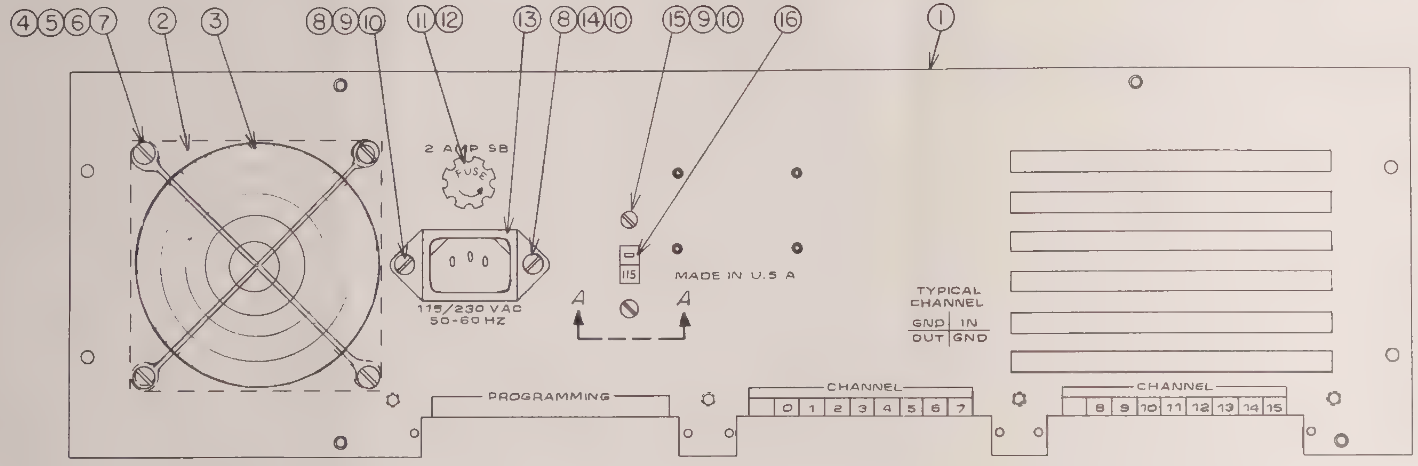
REV A

SCALE

SHEET 1 OF 2

SIZE	DWG NO	REV
C		

LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
A	RELEASE			
B	262	3/27/75		5/28/75
C	692	WNT 11/11/76	RDB	11/11/76
D	922	T.H 5/10/78		5/11/78
E	2071	SR 12/5/85		12/5/85
F	7890	H.C. 1/9/87		


④⑤⑥⑦ ② ③ ⑧⑨⑩ ⑪⑫ ⑬ ⑧⑭⑩ ⑮⑨⑩ ⑯ ①
2 AMP SB
FUSE
115/230 VAC
50-60 HZ
115
MADE IN U.S A
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A
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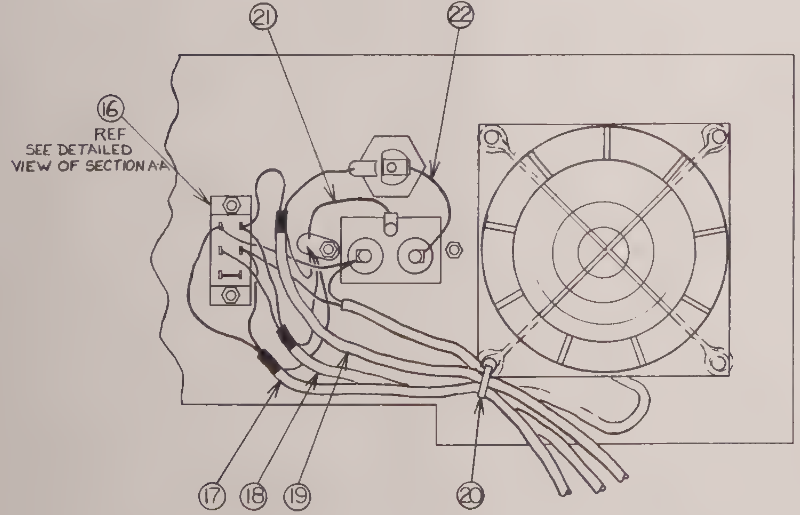
GND | IN
OUT | GND
PROGRAMMING
CHANNEL
0 1 2 3 4 5 6 7
CHANNEL
8 9 10 11 12 13 14 15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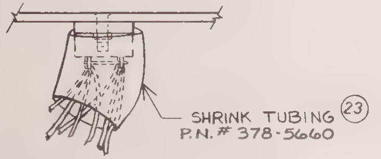
REF
SEE DETAILED
VIEW OF SECTION A-A
⑰ ⑱ ⑲ ⑳


SHRINK TUBING ㉓
P.N. # 378-5660

SECTION A-A

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DATE 7/26/74
CHECKED BY:
ENG APPVL. 5/11/78
MFG APPVL.

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INCHES AFTER FINISHING
AND TOLERANCES ARE
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TITLE
REAR PANEL ASSEMBLY,
816

SIZE C
DRAWING NO. 02 002-0875
REV F
SCALE 1:1
SHEET 1 OF 2

REV	ECN	BY	DATE	APP

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	WIRE #24 AWG STR BLACK			378 1704	1
NONE	CABLE SHIELDED 2COND #24AWG	3211	ALPHA	378 4301	1
NONE	SHRINK TBG PLYFIN BLACK 1/4"			[illegible] 5540	1
NONE	WIRE #24 AWG STR BLACK			378 1704	1
NONE	CABLE SHIELDED 2COND #24AWG	3211	ALPHA	[illegible] 4301	1
NONE	SHRINK TBG PLYFIN BLACK 1/4"			378 5540	1
NONE	SOCKET. INSULATED			353 0105	1
NONE	WIRE. #24 AWG STR BLACK			378 1704	1
NONE	CABLE SHIELDED 2COND #24AWG	3211	ALPHA	378 4301	1
NONE	SHRINK TBG PLYFIN BLACK 1/4"			378 5540	1
NONE	FAN AXL 3 1/8 115V SLV A/P			165 1701	1
NONE	FILTER POWER LINE 3A	3EF1	CORCM	165 3001	1

WAVETEK
PARTS LIST
TITLE REAR PANEL ASSY 816
ASSEMBLY NO 002 0875
REV F
PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
NONE	FUSE· 3AG 2A SB 250V	313002	LITFU	165 4004	1
NONE	PANEL: REAR 816			304 0601	1
NONE	SLIDE SW 115-230 SEL, DPDT, SHORT BAR INSTALLED	46256-LFR	SWCFT	342. 2201	1
NONE	FUSE HOLDER MINI 3 [illegible]	345602	LITFU	351 9951	1
NONE	LUG SOLDER ANGLED #6	1416-6	SMITH	359 0006	1
NONE	GUARD FAN WIRE	760-12601-43	ETRI	366 2001	1
NONE	TIE· CABLE NY NAT 3/4 MAX DIA	SST-1-M	PANDT	377 4001	2
NONE	WIRE. #18 AWG STR GREEN			378 1454	3 50
NONE	WIRE #24 AWG STR BLACK			378 1704	3
	SHRINK TBG PLYFIN BLACK 1"			378 5660	8
NONE	M SCR ST CD SL 4-40 X 3/8PH			380 4062	2
NONE	M SCR ST CD SL 4-40 X 1/2BH			380 4081	2

WAVETEK
PARTS LIST
TITLE REAR PANEL ASSY 816
ASSEMBLY NO 002 0875
REV F
PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	M SCR ST CD SL 6-32 X 1/2BH			380 6081	4
NONE	NUT HX ST CD 4-40 X 1/4AF			387. 4080	4
NONE	NUT HX ST CD 6-32 X 1/4AF			387 6080	4
NONE	WASHER FLAT STL CAD #6			388 0060	4
NONE	WASHER INT LK STL CAD #4			388 1040	3
NONE	WASHER EXT LK STL CAD #6			388 1061	4
NONE	SLEEVING, SHRINKABLE, 1 1/2 IN	GPO-135, 1 1/2	RMTEK	6001-20-2400	1.5

WAVETEK
PARTS LIST
TITLE REAR PANEL ASSY 816
ASSEMBLY NO 002 0875
REV F
PAGE 3

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
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RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX ·010 ANGLES ·1
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DO NOT SCALE DWG
SCALE

WAVETEK SAN DIEGO • CALIFORNIA
TITLE
PARTS LIST
REAR PANEL ASSY
MODEL N 816
DWG NO 002.0875
REV F
CODE IDENT 23338
SHEET 1 OF 1

BISHOP GRAPHICS ACCUPRESS
REORDER NO. 42T38

SIZE	DWG NO	REV
C		

LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
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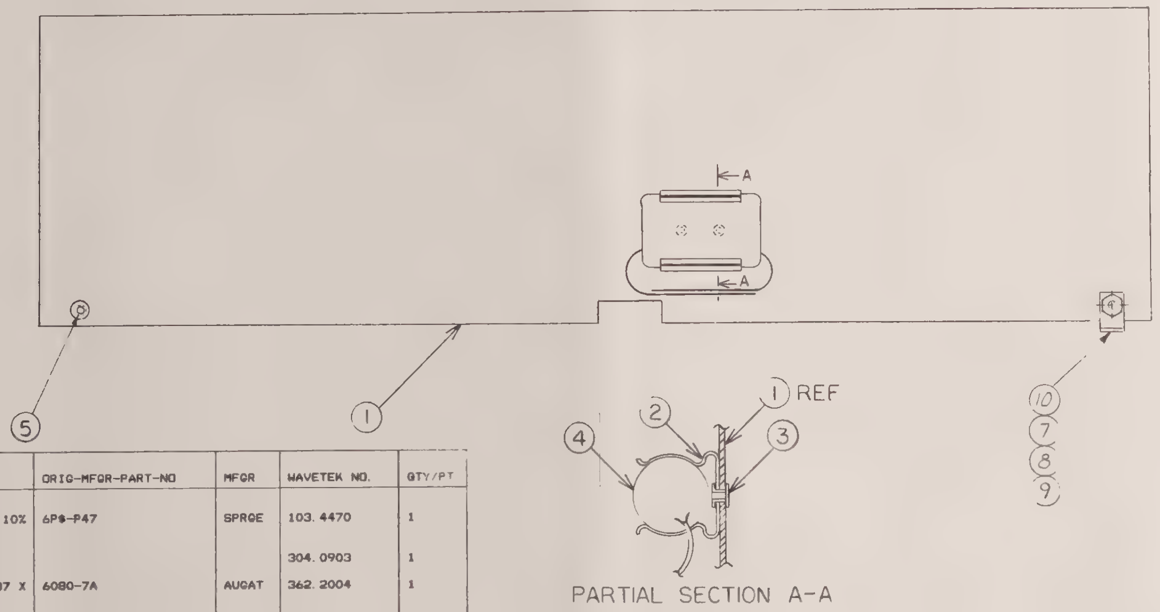
C	919	SJS 4-25-78		5/5/78



PARTIAL SECTION A-A

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	C: FX PAPER .47UF 10% 600V	6P$-P47	SPRGE	103.4470	1
NONE	SHIELD PLATE			304.0903	1
NONE	CLIP: COMP MTG .437 X 1.00	6080-7A	AUGAT	362.2004	1
NONE	M SCR: ST CD SL 4-40 X 3/8PH			380.4062	1
NONE	NUT: HX ST CD 4-40 X 1/4AF			387.4080	1
NONE	WASHER: INT LK STL CAD #4			388.1040	2
NONE	NUT: CLINCH STL CAD 4-40			389.1002	1
NONE	BKT: ANG ST CD 1/2 X 1/2			389.3002	2
NONE	RIVET: STL NI 123DX.156L PH			389.8001	1

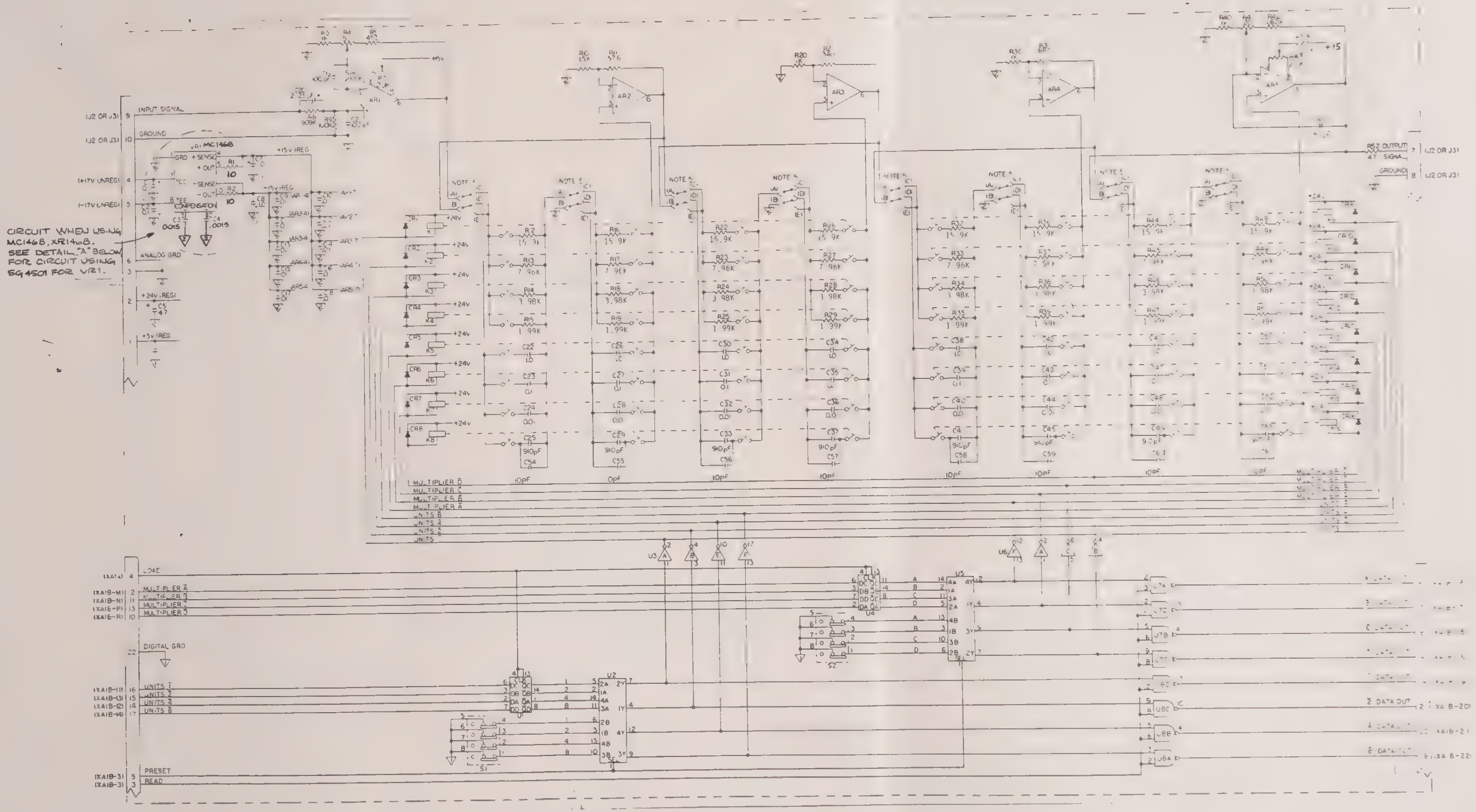
WAVETEK PARTS LIST	TITLE SHIELD PLATE ASSY 816	ASSEMBLY NO. 002.0870	REV C
		PAGE 1	

SHEET 2 IS A SIZE

DRAWN BY: JRd	DATE 9/23/74	**ROCKLAND** Rockland Systems Corporation
CHECKED BY:		
ENG APPVL.	11/11/76	Confidential property of ROCKLAND SYSTEMS CORP. not to be disclosed to others, reproduced or used for any purpose except as authorized in writing by above
MFG APPVL. RDH	11/11/76	
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE: .XXX ± .XX ± X/X ± 1/64 ∠° ± 1° R		TITLE POWER SUPPLY SHIELD PLATE ASSEMBLY 816

SIZE	DRAWING NO.	REV
C	02 002-0870	C
	SCALE 1:1 SHEET 1 OF 2	

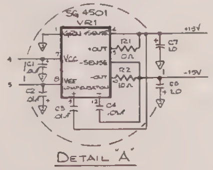
LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	RELEASE	RCP 1-19-76	LHA	1-19-76
B	514	Paul 4/76	RHA	4-13-76
C	712	WNT 12/30/76	RHA	1/24
D	914	S.J.S. 4-11-78		5/25
E	936	T.H 7/78	RHA	[illegible]
F	1015	JB 3 27 79	RHA	4/10/79
G	1112	RHA 2/17/81	RHA	2/17/81
H	[illegible]	1-3		1-3



INPUT SIGNAL
GROUND
(J2 OR J3) 9
(J2 OR J3) 10
VR1 MC1468
GRD +SENSE
+OUT
-SENSE
-OUT
VCC
VEE
COMPENSATION
R1 10
R2 10
C3 .0015
C4 .0015
+15V REG
-15V REG
(+17V UNREG) 4
(-17V UNREG) 5
ANALOG GRD
+24V REG
C5 47
+5V REG
AR1
AR2
AR3
AR4
R6 909K
R9 100K
NOTE 2
15.9K
7.96K
3.98K
1.99K
910pF
10pF
+24V
K1
K2
K3
K4
K5
K6
K7
K8
R52 OUTPUT 47 SIGNAL 7 (J2 OR J3)
GROUND 8 (J2 OR J3)
MULTIPLIER A
MULTIPLIER B
MULTIPLIER C
MULTIPLIER D
UNITS 1
UNITS 2
UNITS 4
UNITS 8
LOAD
(XA14) 4
(XA18-M) 2
(XA18-N) 11
(XA1E-P) 13
(XA1E-R) 10
DIGITAL GRD 22
(XA1E-11) 16
(XA18-13) 15
(XA18-12) 14
(XA18-14) 17
PRESET
READ
(XA18-3) 5
(XA18-3) 3
U1
U2
U3
U4
U5
U6
U7
U8
S1
S2
DATA OUT

CIRCUIT WHEN USING MC1468, XR1468. SEE DETAIL "A" BELOW FOR CIRCUIT USING SG4501 FOR VR1.

6- STANDARD IC USED FOR VR1 IS A MC1468, XR1468. WHEN USING SG 4501 IN THE VR1 POSITION; NOTE THE VALUE CHANGE OF C3 & C4 AND CIRCUITRY CHANGE.



SG 4501
VR1
GRD
+SENSE
+OUT
VCC
-SENSE
VEE
-OUT
COMPENSATION
R1 0Ω
R2 10Ω
C1 .1uF
C2 .1uF
C3 .01uF
C4 .01uF
C7 1.0
C8 1.0
+15V
-15V

DETAIL "A"

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.

2. JUMPERS ARE SHOWN IN LOW PASS CONFIGURATION. PIN A TO PIN C AND PIN B TO PIN D. FOR HIGH-PASS CONFIGURATION, CONNECT PIN A TO PIN D AND PIN B TO PIN E. ALL JUMPERS MUST BE CONNECTED THE SAME WAY.

HIGHEST REF DESIG USED.

AR5 C63 CR16 K16 R54 S2 U8 VR1

IC REF DES	
U1	122-7475
U2	0112
U3	7406
U4	7475
U5	0112
U6	7406
U7	7401
U8	122 7401

DRAWN BY: RCP	DATE 1-19-76	**ROCKLAND** Rockland Systems Corporation
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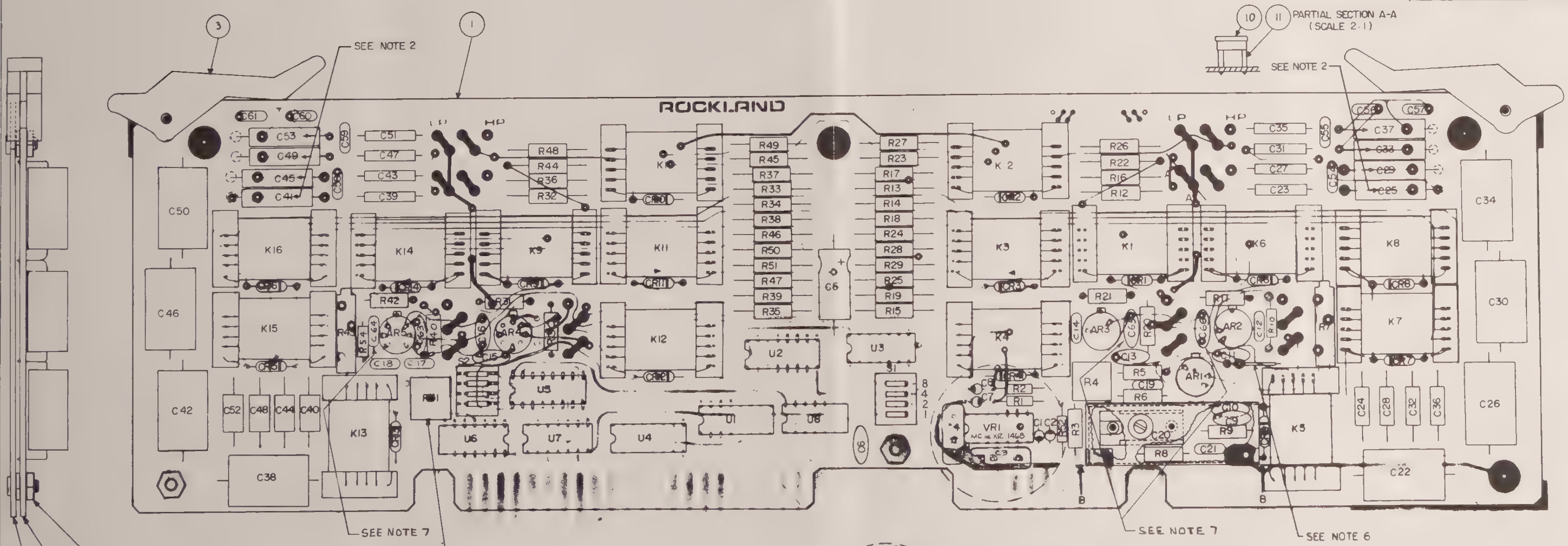
ENG APPVL.	2/2/76	
MFG APPVL.	1-27	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

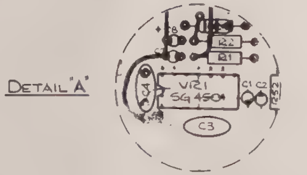
TITLE
SCHEMATIC DIAGRAM
FILTER CARD
BUTTERWORTH 10Hz 150KHz

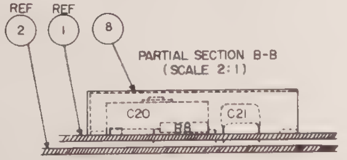
SIZE D | 03 | DRAWING NO. 004-0830 | REV H
SCALE | SHEET 1 OF 1

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
C	157	ARJ	RAH	9/5/74
D	264	[illegible]	RAH	[illegible] 75
E	[illegible]	Paul 4/76	[illegible]	4 13 76
F	513	WNT 7/[illegible]	RAH	7/2/76
[illegible]	703	[illegible]	[illegible]	[illegible]/24/77
H	914	SJC 4 11 78	RAH	[illegible] 26/78
J	936	TH 6 78	RAH	7/9/78
K	0.5	JB 3-27-79	RAH	[illegible]/10/79
L	1132	[illegible]	RAH	6/22/80
M	1154	SM 2 11-80	RAH	2/10/81
N	[illegible]69	RAH 2/20/81	RAH	2/20/81
P	2236	[illegible]	[illegible]	[illegible] 9/8


③
①
SEE NOTE 2
ROCKLAND
LP
HP
K16
K14
K9
K11
K15
K12
K13
K2
K3
K1
K6
K8
K7
K4
K5
U1
U2
U3
U4
U5
U6
U7
U8
S1
VR1
AR1
AR2
AR3
AR4
AR5
C50
C46
C42
C38
C34
C30
C26
C22
C6
A
B
⑩ ⑪ PARTIAL SECTION A-A
(SCALE 2:1)
SEE NOTE 2
SEE NOTE 7
⑦ SEE NOTE 3
SEE NOTE 7
SEE NOTE 6
④ ⑤ ⑥
① REF
②

DETAIL "A"


VR1
SG 450
R1
R2
C1
C2
C3
R4
R32


REF
②
REF
①
⑧
C20
C21
R8

PARTIAL SECTION B-B
(SCALE 2:1)

NOTES:

1. STAMP APPLICABLE ASSEMBLY PART NUMBER AND REVISION LETTER PER INK SPEC DRAWING NO. 00-996-0001.
2. C25, C29, C33, C37, C41, C45, C49, AND C53 MAY BE TYPE CM05 INSTEAD OF AS SHOWN. MOUNT CM05 TYPE CAPACITORS BETWEEN DASHED-OUTLINE PADS.
3. RANGE-MULTIPLIER LABEL ITEM 7 IS TRIMMED TO FIT R41. SELF ADHESIVE HOLDS LABEL IN PLACE AFTER R41 IS ADJUSTED. FOR 004-0830 ASSEMBLY, TRIM LABEL TO SHOW X10, X100, X1K, X10K.

4. LEAD PROTRUSION THRU BOARD TO BE .062 MAX.
5. SHEETS 2 THRU 5 ARE "A" SIZE (L/M).
6. CONNECT JUMPER TO + SUPPLY FOR OP AMP # 120-1014 & 120-1007
7. SELECT C64, C65, C66, IN TEST.

STANDARD CONFIGURATION

VR1 IS MC1468 OR XR1468 (120-0152)
C3 & C4 ARE .0015 uF. (105-2150)
REFER TO MAIN ASSY. DRAWING.

ALTERNATE CONFIGURATION

VR1 IS SG 4501 (120-0157)
C3 & C4 ARE .01 uF (100-3101)
REFER TO DETAIL "A".

SHEETS 2 THRU 5 ARE "A" SIZE L/M

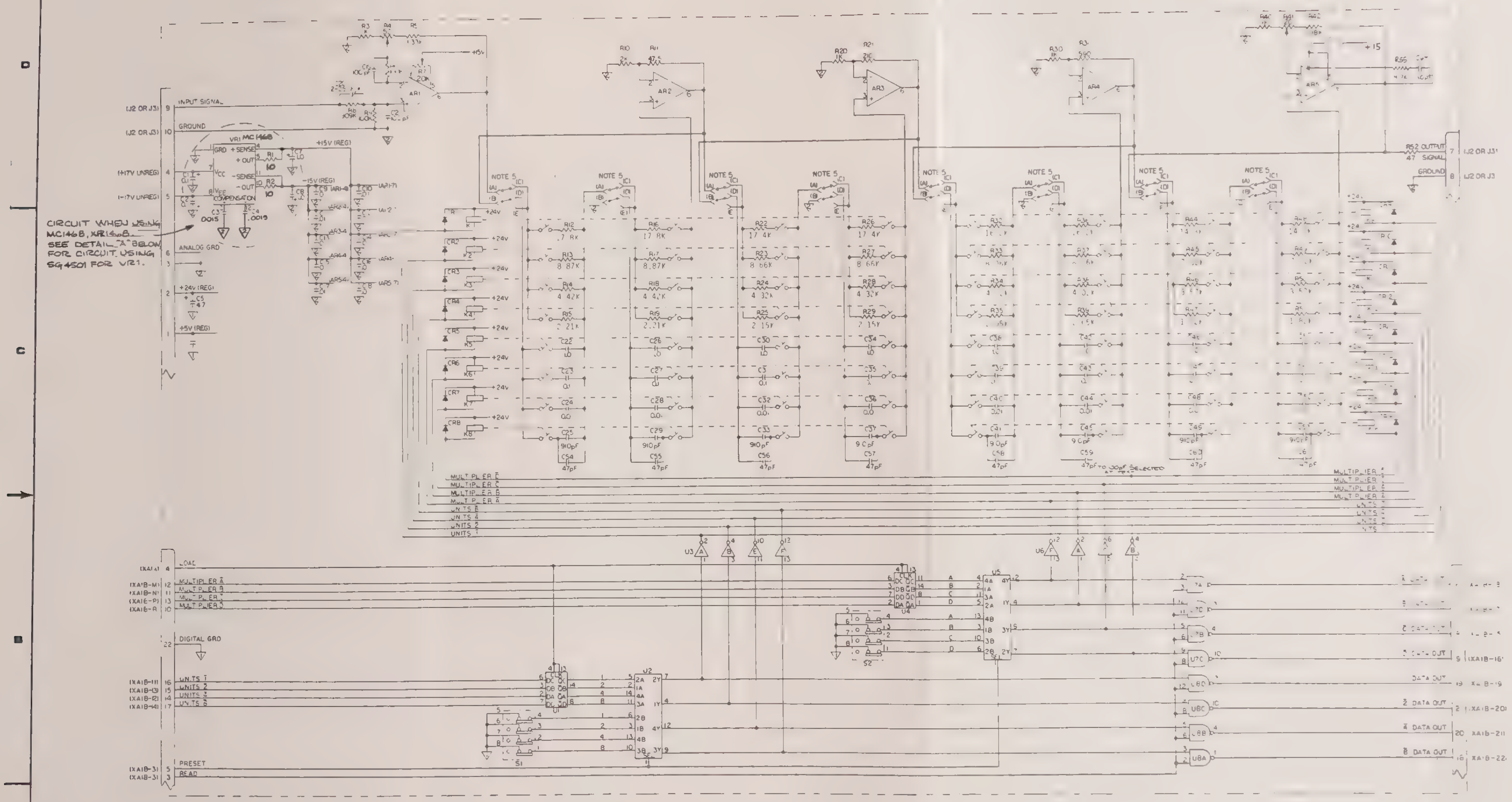
DRAWN BY ARJ	DATE 9/5/74	**ROCKLAND** Rockland Systems Corporation	
CHECKED BY RAH	9/11/74	Confidential property of ROCKLAND SYSTEMS CORP not to be disclosed to others reproduced or used for any purpose except as authorized in writing by above	
ENG APPVL RAH	9/11/74		
MFG APPVL B.F.	9/12/74		
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE XXX ± XX ± X/X ± 1/64 ∠° ± 1°		TITLE PCB ASSEMBLY, 10 Hz - 150 KHz BUTTERWORTH FILTER	
SIZE D	02	DRAWING NO 004-0830	REV [illegible]
		SCALE 2:1	SHEET 1 OF 5

REF. DES.	DESCRIPTION	PART NO.
	BUTTERWORTH 10 Hz-150 KHz FILTER ASSEMBLY (01) p.n. 004-0830	
AR1	IC AMPL: Linear Op-Amp	120-1014
AR2	IC AMPL: Linear Op-Amp	120-1014
AR3	IC AMPL: Linear Op-Amp	120-1014
AR4	IC AMPL: Linear Op-Amp	120-1007
AR5	IC AMPL: Linear Op-Amp	120-1007
C1	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C2	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C3	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C4	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C5	CAP: Fxd elect 50uF 25 V	109-6500
C6	CAP: Fxd cer 0.1uF +80 -20% 15 V	100-4100
C7	CAP: Fxd tant 1uF 20% 35 V	109-5100
C8	CAP: Fxd tant 1uF 20% 35 V	109-5100
C9	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C10	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C11	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C12	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C13	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C14	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C15	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C16	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C17	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C18	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C19	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C20	CAP: Var mica 2-25pF 175 V	108-0250
C21	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C22	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C23	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C24	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C25	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C26	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C27	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C28	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C29	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C30	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C31	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C32	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C33	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C34	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C35	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C36	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C37	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C38	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C39	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C40	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C41	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C42	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C43	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100

REF. DES.	DESCRIPTION	PART NO.
	BUTTERWORTH 10 Hz-150 KHz FILTER ASSEMBLY (01) p.n. 004-0830 (cont)	
C44	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C45	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C46	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C47	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C48	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C49	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C50	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C51	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C52	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C53	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C54	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C55	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C56	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C57	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C58	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C59	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C60	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C61	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C63	CAP Fxd mica dipped, 47pf 10% 500V	101-0470
CR1	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR2	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR3	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR4	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR5	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR6	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR7	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR8	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR9	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR10	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR11	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR12	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR13	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR14	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR15	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR16	DIO: Sil low leak 70 PIV 200 mA	132-0457
K1	REL: Reed 4PST 24 V 180 mA	175-1503
K2	REL: Reed 4PST 24 V 180 mA	175-1503
K3	REL: Reed 4PST 24 V 180 mA	175-1503
K4	REL: Reed 4PST 24 V 180 mA	175-1503
K5	REL: Reed 4PST 24 V 180 mA	175-1503
K6	REL: Reed 4PST 24 V 180 mA	175-1503
K7	REL: Reed 4PST 24 V 180 mA	175-1503
K8	REL: Reed 4PST 24 V 180 mA	175-1503
K9	REL: Reed 4PST 24 V 180 mA	175-1503
K10	REL: Reed 4PST 24 V 180 mA	175-1503
K11	REL: Reed 4PST 24 V 180 mA	175-1503
K12	REL: Reed 4PST 24 V 180 mA	175-1503
K13	REL: Reed 4PST 24 V 180 mA	175-1503

REF. DES.	DESCRIPTION	PART NO.
	BUTTERWORTH 10 Hz-150 KHz FILTER ASSEMBLY (01) p.n. 004-0830 (cont)	
R46	RES: Fxd metflm 3.98K 1% 1/8W	111-3980
R47	RES: Fxd metflm 1.99K 1% 1/8W	111-1990
R48	RES: Fxd metflm 15.9K 1% 1/8W	112-1590
R49	RES: Fxd metflm 7.96K 1% 1/8W	111-7960
R50	RES: Fxd metflm 3.98K 1% 1/8W	111-3980
R51	RES: Fxd metflm 1.99K 1% 1/8W	111-1990
R52	RES: Fxd comp 47 ohm 5% 1/4W	116-0471
R54	RES: Fxd metflm 200K 1% 1/10W	113-2001
S1	SW: Slide SPST X4	342-4100
S2	SW: Slide SPST X4	342-4100
U1	IC: Quad Bistable latch	122-7475
U2	IC: Quad 2-input Data Sel/MLPX	122-0112
U3	IC: Hex inverter buffer/driver O/C	122-7406
U4	IC: Quad Bistable latch	122-7475
U5	IC: Quad 2-input Data Sel/MLPX	122-0112
U6	IC: Hex inverter buffer/driver O/C	122-7406
U7	IC: Quad 2-input NAND O/C	122-7401
U8	IC: Quad 2-input NAND O/C	122-7401
VR1	REG: Dual ± 15 volt 100 mA	120-0152
	Serial Number Label	371-1000
	IC Socket (For AR2)	353-0801
	IC Socket (For AR3)	353-0801
	IC Socket (For AR4)	353-0801
	IC Socket (For AR5)	353-0801

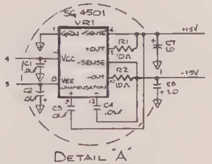
LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A				


CIRCUIT WHEN USING MC1468, XR1468. SEE DETAIL "A" BELOW FOR CIRCUIT USING SG4501 FOR VR1.
INPUT SIGNAL
(J2 OR J3) 9
GROUND
(J2 OR J3) 10
VR1 MC1468
GRD +SENSE
+OUT
VCC
-SENSE
-OUT
VEE
COMPENSATION
C3 .0015
C4 .0015
R1 10
R2 10
+15V (REG)
-15V (REG)
(+17V UNREG) 4
(-17V UNREG) 5
ANALOG GRD 6
+24V (REG) 2
C5 47
+5V (REG) 1
AR1
AR2
AR3
AR4
AR5
NOTE 5
+24V
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
K1
K2
K3
K4
K5
K6
K7
K8
R12 17.8K
R13 8.87K
R14 4.42K
R15 2.21K
R16 17.8K
R17 8.87K
R18 4.42K
R19 2.21K
R22 17.4K
R23 8.66K
R24 4.32K
R25 2.15K
R26 17.4K
R27 8.66K
R28 4.32K
R29 2.15K
C25 910pF
C54 47pF
C55 47pF
C56 47pF
C57 47pF
C58 47pF
C59 47pF TO 100pF SELECTED
R52 47 OUTPUT SIGNAL
7 (J2 OR J3)
GROUND
8 (J2 OR J3)
+15
MULTIPLIER 8
MULTIPLIER 4
MULTIPLIER 2
MULTIPLIER 1
UNITS 8
UNITS 4
UNITS 2
UNITS 1
U3
U6
(XA1-4) 4 LOAD
(XA1B-M) 12 MULTIPLIER 1
(XA1B-N) 11 MULTIPLIER 8
(XA1E-P) 13 MULTIPLIER 4
(XA1B-R) 10 MULTIPLIER 2
22 DIGITAL GRD
(XA1B-11) 16 UNITS 1
(XA1B-13) 15 UNITS 2
(XA1B-12) 14 UNITS 4
(XA1B-14) 17 UNITS 8
U1
U2
U4
U5
S1
S2
(XA1B-3) 5 PRESET
(XA1B-3) 3 READ
U7C
U8D
U8C
U8B
U8A
DATA OUT
1 DATA OUT 2 (XA1B-20)
4 DATA OUT 20 (XA1B-21)
8 DATA OUT 16 (XA1B-22)
2 DATA OUT 5 (XA1B-16)
DATA OUT 19 (XA1B-19)

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.

6- STANDARD IC USED FOR VR1 IS A MC1468, XR1468. WHEN USING SG 4501 IN THE VR1 POSITION; NOTE THE VALUE CHANGE OF C3 + C4 AND CIRCUITRY CHANGE.


SG 4501
VR1
GRD +SENSE
+OUT
VCC
-SENSE
-OUT
VEE
COMPENSATION
R1 10Ω
R2 10Ω
C1 .01
C2 .01
C3 .01
C4 .001
C7 1.0
C8 1.0
+15V
-15V
4
5

DETAIL "A"

HIGHEST REF DESIG USED.

AR5 C63 CR16 K16 R54 S2 U8 VR1

IC REF DES	
U1	122-7475
U2	0112
U3	7406
U4	7475
U5	0112
U6	7406
U7	7401
U8	122 7401

2. JUMPERS ARE SHOWN IN LOW PASS CONFIGURATION. PIN A TO PIN C AND PIN B TO PIN D. FOR HIGH-PASS CONFIGURATION CONNECT PIN A TO PIN D AND PIN B TO PIN E. ALL JUMPERS MUST BE CONNECTED THE SAME WAY.

DRAWN BY	DATE
CHECKED BY	
ENG APPVL.	
MFG APPVL.	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:

.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

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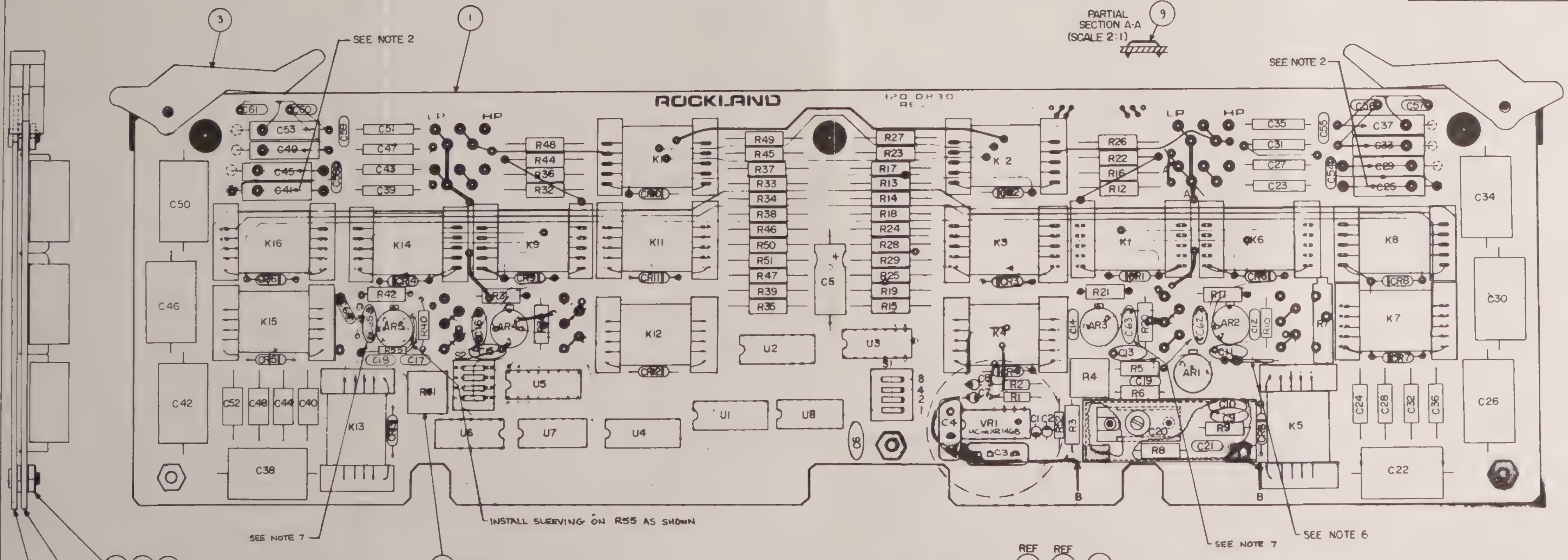
TITLE
SCHEMATIC DIAGRAM
FILTER CARD
BESSEL 10Hz-150KHz

SIZE D | 03 | DRAWING NO. 004-0635 | REV A
SCALE | SHEET 1 OF 1

LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
C	157	HRJ	RHH	9/5/74
D	265	DJ 5/20/75	RHH	5/20/75
E	455	[illegible] 6/16/76	RHH	7/2/76
F	704	WHT 12-16-76	RHH	1/5/77
G	741	DF 3-9-77	RHH	3/10/77
H	914	SJS 4-11-78	RHH	5/26/78
J	936	T.H. 6-78	RHH	7/11/78
K	1015	JB 3-27-79	RHH	4/10/79
L	1112	SAM 4-21-80	RHH	
M	1154	RHH 2/16/81	RHH	2/17/81
N	1169	RHH 2/20/81	RHH	2/20/81
P	2135	NP 5/13/86		

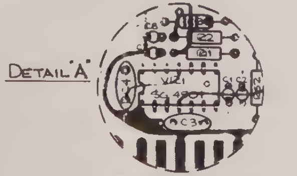


3
1
SEE NOTE 2
PARTIAL SECTION A-A (SCALE 2:1)
9
SEE NOTE 2
ROCKLAND
120 0830
LP
HP
C61
C60
C53
C49
C45
C41
C59
C51
C47
C43
C39
C50
C46
C42
R48
R44
R36
R32
K10
CR10
R49
R45
R37
R33
R34
R38
R46
R50
R51
R47
R39
R35
R27
R23
R17
R13
R14
R18
R24
R28
R29
R25
R19
R15
K2
CR2
C5
R26
R22
R16
R12
C35
C31
C27
C23
C55
C54
C58
C57
C37
C33
C29
C25
C34
C30
C26
C22
K16
K14
K9
K11
K3
K1
K6
K8
K15
K12
K4
K7
K13
K5
CR16
CR14
CR9
CR11
CR3
CR1
CR6
CR8
CR15
CR12
CR4
CR7
CR5
R42
R31
AR5
AR4
AR3
AR2
AR1
R40
R55
C18
C17
C16
C15
S2
S1
8 4 2 1
R41
U2
U3
U5
U1
U8
U6
U7
U4
R21
R11
C14
C63
C62
C12
R10
R7
C13
C11
R5
R4
C19
R6
R2
R1
C4
VR1
MC or XR1468
C1
C2
C3
R3
C20
R9
C10
C9
R8
C21
C52
C48
C44
C40
C38
C24
C28
C32
C36
B
B
SEE NOTE 7
INSTALL SLEEVING ON R55 AS SHOWN
SEE NOTE 7
SEE NOTE 6
4
5
6
1 REF
2
7 SEE NOTE 3

NOTES:

1. STAMP APPLICABLE ASSEMBLY PART NUMBER AND REVISION LETTER PER INK SPEC DRAWING NO. 00-995-0001.
2. C25, C29, C33, C37, C41, C45, C49, AND C53 MAY BE TYPE CM05 INSTEAD OF AS SHOWN. MOUNT CM05 TYPE CAPACITORS BETWEEN DASHED-OUTLINE PADS.
3. RANGE-MULTIPLIER LABEL ITEM 7 IS TRIMMED TO FIT R41. SELF ADHESIVE HOLDS LABEL IN PLACE AFTER R41 IS ADJUSTED. FOR 004-0835 ASSEMBLY, TRIM LABEL TO SHOW X10, X100, X1K, X10K.
4. LEAD PROTRUSION THRU BOARD TO BE .062 MAX.
5. SHEETS 2 THRU 5 ARE "A" SIZE (L/M).
6. CONNECT JUMPER TO + SUPPLY FOR OP AMP # 120-1007 & 120-1014
7. SELECT C62, C63, & C65 IN TEST

DETAIL "A"



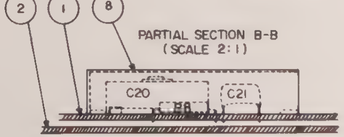
C8
C7
22
21
VR1
SG 4501
C4
C3
C1
C2

STANDARD CONFIGURATION

VR1 IS MC1468 or XR1468 (120-0152)
C3 & C4 ARE .0015uf (105-2150)
REFER TO MAIN ASSY DRAWING.

ALTERNATE CONFIGURATION

VR1 IS SG 4501 (120-0157)
C3 & C4 ARE .01uf (100-3101)
REFER TO DETAIL "A".



REF 2
REF 1
8
C20
C21
R8

PARTIAL SECTION B-B
(SCALE 2:1)

SHEETS 2 - 5 ARE "A" SIZE L/M

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MFG APPVL	B.R.	9/12/74	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
XXX ±
XX ±
X/X ± 1/64
∠° ± 1°

TITLE
PCB ASSEMBLY, 10 Hz - 150 KHz
BESSEL FILTER

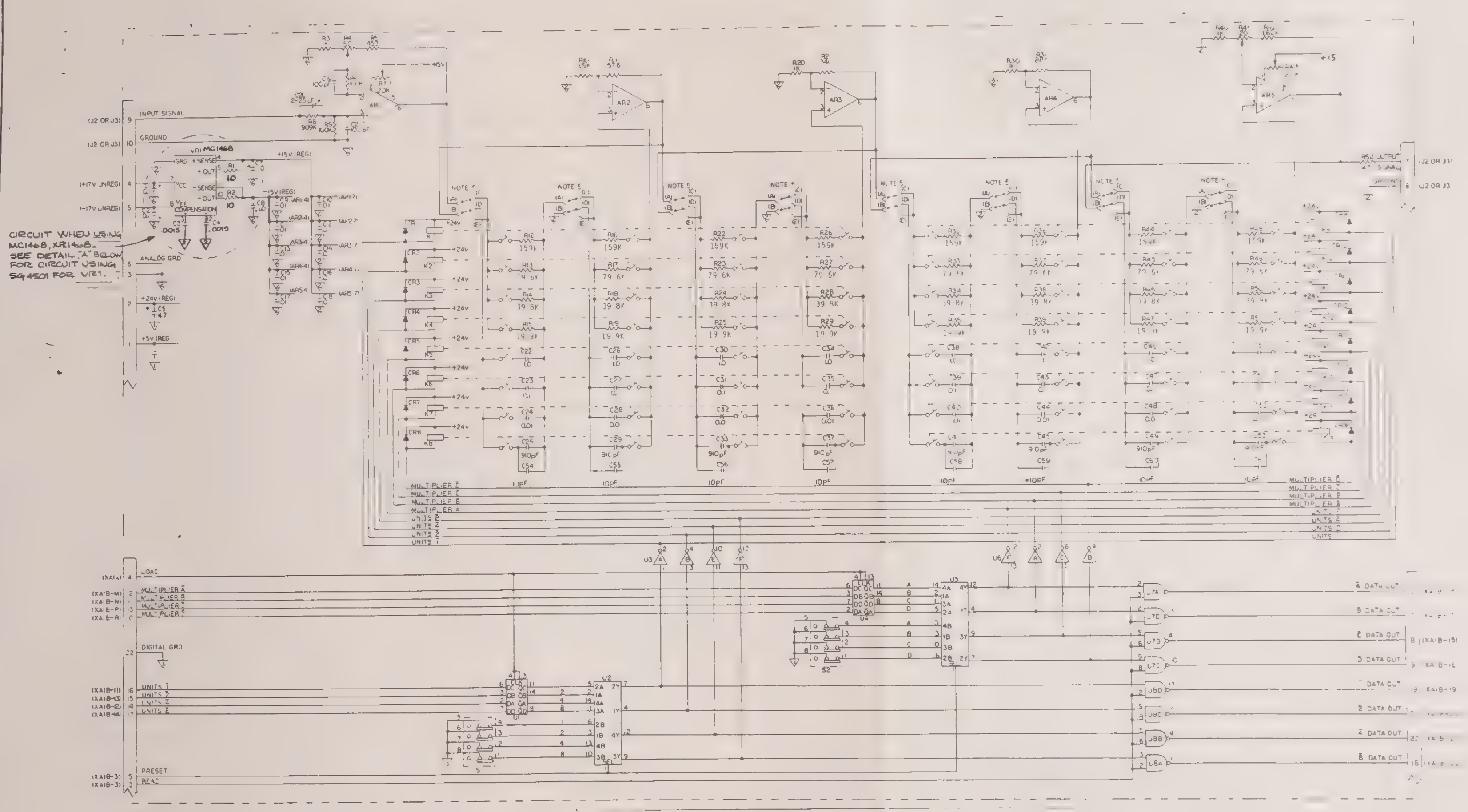
SIZE D | 02 | DRAWING NO 004-0835 | REV P
SCALE 2:1 | SHEET 1 OF 5

REF. DES.	DESCRIPTION	PART NO.
	BESSEL 10 Hz-150 KHz FILTER ASSEMBLY (05) p.n. 004-0835	
AR1	IC AMPL: Linear Op-Amp	120-1014
AR2	IC AMPL: Linear Op-Amp	120-1007
AR3	IC AMPL: Linear Op-Amp	120-1007
AR4	IC AMPL: Linear Op-Amp	120-1007
AR5	IC AMPL: Linear Op-Amp	120-1007
C1	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C2	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C3	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C4	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C5	CAP: Fxd elect 50uF 25 V	109-6500
C6	CAP: Fxd cer 0.1uF +80 -20% 15 V	100-4100
C7	CAP: Fxd tant 1uF 20% 35 V	109-5100
C8	CAP: Fxd tant 1uF 20% 35 V	109-5100
C9	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C10	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C11	CAP: Fxd cer 0 ..01uF +80 -20% 30 V	100-3101
C12	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C13	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C14	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C15	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C16	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C17	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C18	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C19	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C20	CAP: Var mica 2-25pF 175 V	108-0250
C21	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C22	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C23	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C24	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C25	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C26	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C27	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C28	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C29	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C30	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C31	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C32	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C33	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C34	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C35	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C36	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C37	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C38	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C39	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C40	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C41	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C42	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C43	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100

REF. DES.	DESCRIPTION	PART NO.
	BESSEL 10 Hz-150 KHz FILTER ASSEMBLY (05) p.n. 004-0835 (cont)	
C44	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C45	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C46	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C47	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C48	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C49	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C50	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C51	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C52	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C53	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C54	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C55	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C56	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C57	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C58	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C59	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C60	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
C61	CAP: Fxd mica dipped 47 pF 10% 500V	101-0470
CR1	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR2	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR3	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR4	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR5	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR6	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR7	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR8	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR9	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR10	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR11	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR12	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR13	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR14	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR15	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR16	DIO: Sil low leak 70 PIV 200 mA	132-0457
K1	REL: Reed 4PST 24 V 180 mA	175-1503
K2	REL: Reed 4PST 24 V 180 mA	175-1503
K3	REL: Reed 4PST 24 V 180 mA	175-1503
K4	REL: Reed 4PST 24 V 180 mA	175-1503
K5	REL: Reed 4PST 24 V 180 mA	175-1503
K6	REL: Reed 4PST 24 V 180 mA	175-1503
K7	REL: Reed 4PST 24 V 180 mA	175-1503
K8	REL: Reed 4PST 24 V 180 mA	175-1503
K9	REL: Reed 4PST 24 V 180 mA	175-1503
K10	REL: Reed 4PST 24 V 180 mA	175-1503
K11	REL: Reed 4PST 24 V 180 mA	175-1503
K12	REL: Reed 4PST 24 V 180 mA	175-1503
K13	REL: Reed 4PST 24 V 180 mA	175-1503

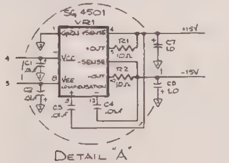
REF. DES.	DESCRIPTION	PART NO.
	BESSEL 10 Hz-150 KHz FILTER ASSEMBLY (05) p.n. 004-0835 (cont)	
R45	RES: Fxd metflm 7.32K 1% 1/8W	111-7320
R46	RES: Fxd metflm 3.57K 1% 1/8W	111-3570
R47	RES: Fxd metflm 1.82K 1% 1/8W	111-1820
R48	RES: Fxd metflm 14.3K 1% 1/8W	112-1430
R49	RES: Fxd metflm 7.32K 1% 1/8W	111-7320
R50	RES: Fxd metflm 3.57K 1% 1/8W	111-3570
R51	RES: Fxd metflm 1.82K 1% 1/8W	111-1820
R52	RES: Fxd comp 47 ohm 5% 1/4W	116-0471
S1	SW: Slide SPST X4	342-4100
S2	SW: Slide SPST X4	342-4100
U1	IC: Quad Bistable latch	122-7475
U2	IC: Quad 2-input Data Sel/MLPX	122-0112
U3	IC: Hex inverter buffer/driver O/C	122-7406
U4	IC: Quad Bistable latch	122-7475
U5	IC: Quad 2-input Data Sel/MLPX	122-0112
U6	IC: Hex inverter buffer/driver O/C	122-7406
U7	IC: Quad 2-input NAND O/C	122-7401
U8	IC: Quad 2-input NAND O/C	122-7401
VR1	REG: Dual ± 15 volt 100 mA	120-0152
	Serial Number Label	371-1000
	IC Socket (For AR2)	353-0801
	IC Socket (For AR3)	353-0801
	IC Socket (For AR4)	353-0801
	IC Socket (For AR5)	353-0801

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A				


INPUT SIGNAL
GROUND
J2 OR J3
+17V UNREG
-17V UNREG
VR1 MC1468
+15V (REG)
-15V (REG)
COMPENSATION
ANALOG GRD
+24V (REG)
+5V (REG)
AR1
AR2
AR3
AR4
AR5
NOTE 2
+24V
MULTIPLIER
UNITS
LOAD
DIGITAL GRD
PRESET
READ
U1
U2
U3
U4
U5
U6
S1
S2
DATA OUT

CIRCUIT WHEN USING MC1468, XR1468. SEE DETAIL "A" BELOW FOR CIRCUIT USING SG4501 FOR VR1.

6- STANDARD IC USED FOR VR1 IS A MC1468, XR1468. WHEN USING SG 4501 IN THE VR1 POSITION; NOTE THE VALUE CHANGE OF C3 & C4 AND CIRCUITRY CHANGE.


SG 4501
VR1
+15V
-15V
R1
R2
C7
C8
C3
C4

DETAIL "A"

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.

2. JUMPERS ARE SHOWN IN 'LOW' PASS CONFIGURATION. PIN A TO PIN C AND PIN B TO PIN D. FOR HIGH-PASS CONFIGURATION CONNECT PIN A TO PIN D AND PIN B TO PIN E. ALL JUMPERS MUST BE CONNECTED THE SAME WAY.

HIGHEST REF DESIG USED.
AR5 C63 CR16 K16 R54 S2 U8 VR1

IC REF DES	
U1	122-7475
U2	0112
U3	7406
U4	7475
U5	0112
U6	7406
U7	7401
U8	122 7401

DRAWN BY	DATE
CHECKED BY	
ENG APPVL.	
MFG APPVL.	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

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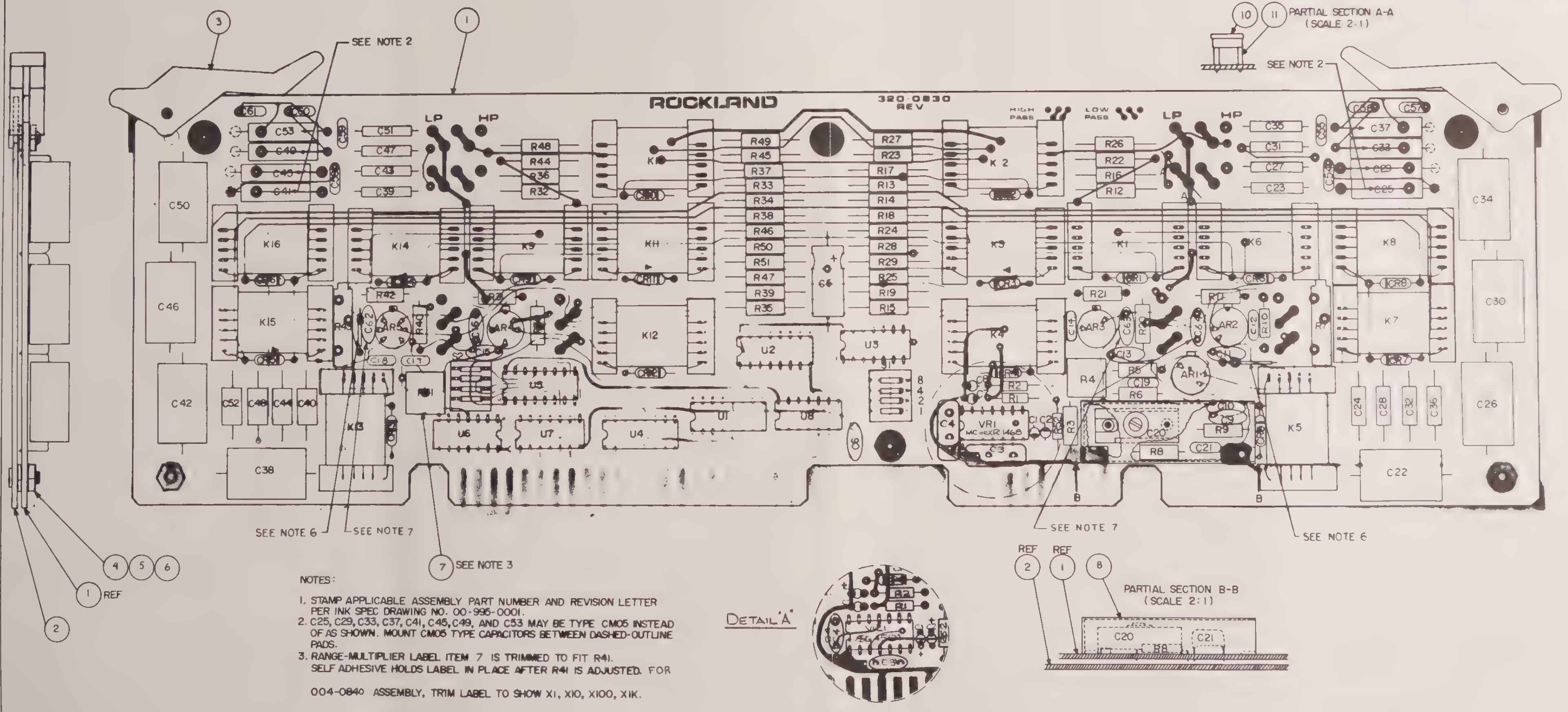
TITLE
SCHEMATIC DIAGRAM
FILTER CARD
BUTTERWORTH 1Hz - 15KHz

SIZE D
03
DRAWING NO. 004-0840
REV A
SCALE N/A
SHEET 1 OF 1

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
C	157	AQJ	RHH	9/5/74
D	266	[illegible]	RHH	7/28/75
E	455	WNT [illegible]/76	[illegible]	[illegible]
F	[illegible]	[illegible]	[illegible]	[illegible]
G	714	[illegible] 4 [illegible]	[illegible]	[illegible]
H	936	TH [illegible]	[illegible]	[illegible]
J	1015	[illegible] 3 [illegible] 79	[illegible]	[illegible]
K	1132	[illegible]	[illegible]	5/2[illegible]/8[illegible]
L	1154	SM [illegible]/80	[illegible]	[illegible]
M	1169	[illegible] 2/21/81	[illegible]	[illegible]
N	2236	[illegible] 9/[illegible]	[illegible]	[illegible]/85


ROCKLAND
320-0830
REV
HIGH PASS
LOW PASS
LP
HP
LP
HP
SEE NOTE 2
SEE NOTE 2
PARTIAL SECTION A-A
(SCALE 2:1)
10
11
3
1
A
A
B
B
K1
K2
K3
K4
K5
K6
K7
K8
K9
K11
K12
K13
K14
K15
K16
C50
C46
C42
C38
C34
C30
C26
C22
C52
C48
C44
C40
C24
C28
C32
C36
AR1
AR2
AR3
AR4
AR5
U1
U2
U3
U4
U5
U6
U7
U8
VR1
MC or XR 1468
R41
S1
S2
C6
8
4
2
1
SEE NOTE 6
SEE NOTE 7
SEE NOTE 7
SEE NOTE 6
7
SEE NOTE 3
4
5
6
1
REF
2
DETAIL 'A'
REF
REF
2
1
8
PARTIAL SECTION B-B
(SCALE 2:1)
C20
C21
R8

NOTES:

1. STAMP APPLICABLE ASSEMBLY PART NUMBER AND REVISION LETTER PER INK SPEC DRAWING NO. 00-996-0001.
2. C25, C29, C33, C37, C41, C45, C49, AND C53 MAY BE TYPE CM05 INSTEAD OF AS SHOWN. MOUNT CM05 TYPE CAPACITORS BETWEEN DASHED-OUTLINE PADS.
3. RANGE-MULTIPLIER LABEL ITEM 7 IS TRIMMED TO FIT R41.
   SELF ADHESIVE HOLDS LABEL IN PLACE AFTER R41 IS ADJUSTED. FOR

   004-0840 ASSEMBLY, TRIM LABEL TO SHOW X1, X10, X100, X1K.

4. LEAD PROTRUSION THRU BOARD TO BE .062 MAX.
5. SHEETS 2 THRU 5 ARE "A" SIZE (L/M).
6. CONNECT JUMPER TO + SUPPLY FOR OP AMP # 120-1014
7. SELECT C62, C63, C64, IN TEST.

STANDARD CONFIGURATION
VR1 IS MC1468 OR XR1468 (120-0152)
C3,C4 ARE .0015 uf (105-2150)
REFER TO MAIN ASSY DRAWING.

ALTERNATE CONFIGURATION
VR1 IS SG 4501 (120-0157)
C3,C4 ARE .01uf (100-3101)
REFER TO DETAIL "A".

DRAWN BY	AQJ	DATE 9/5/74	**ROCKLAND** Rockland Systems Corporation
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ENG APPVL	RHH	9/11/74	
MFG APPVL	A.R.	9/12/74	

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE
XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

TITLE
PCB ASSEMBLY, 1 Hz - 15 KHz
BUTTERWORTH FILTER

SIZE		DRAWING NO	REV
D	02	004-0840	N
	SCALE 2:1	SHEET 1 OF 5	

REF. DES.	DESCRIPTION	PART NO.
	BUTTERWORTH 1 Hz-15 KHz FILTER ASSEMBLY (02) p.n. 004-0840	
AR1	IC AMPL: Linear Op-Amp	120-1014
AR2	IC AMPL: Linear Op-Amp	120-1014
AR3	IC AMPL: Linear Op-Amp	120-1014
AR4	IC AMPL: Linear Op-Amp	120-1014
AR5	IC AMPL: Linear Op-Amp	120-1014
C1	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C2	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C3	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C4	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C5	CAP: Fxd elect 50uF 25 V	109-6500
C6	CAP: Fxd cer 0.1uF +80 -20% 15 V	100-4100
C7	CAP: Fxd tant 1uF 20% 35 V	109-5100
C8	CAP: Fxd tant 1uF 20% 35 V	109-5100
C9	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C10	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C11	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C12	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C13	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C14	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C15	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C16	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C17	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C18	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C19	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C20	CAP: Var mica 2-25pF 175 V	108-0250
C21	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C22	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C23	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C24	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C25	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C26	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C27	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C28	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C29	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C30	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C31	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C32	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C33	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C34	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C35	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C36	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C37	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C38	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C39	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C40	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C41	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C42	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C43	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C44	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100

REF. DES.	DESCRIPTION	PART NO.
	BUTTERWORTH 1 Hz-15 KHz FILTER ASSEMBLY (02) p.n. 004-0840 (cont)	
C45	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C46	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C47	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C48	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C49	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C50	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C51	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C52	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C53	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C54	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C55	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C56	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C57	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C58	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C59	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C60	CAP: Fxd mica dipped 10 pF 10% 500 V	101-0100
C61	CAP: Fxd mica dipped 10 pF 10% 500 V	101-0100
CR1	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR2	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR3	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR4	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR5	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR6	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR7	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR8	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR9	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR10	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR11	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR12	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR13	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR14	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR15	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR16	DIO: Sil low leak 70 PIV 200 mA	132-0457
K1	REL: Reed 4PST 24 V 180 mA	175-1503
K2	REL: Reed 4PST 24 V 180 mA	175-1503
K3	REL: Reed 4PST 24 V 180 mA	175-1503
K4	REL: Reed 4PST 24 V 180 mA	175-1503
K5	REL: Reed 4PST 24 V 180 mA	175-1503
K6	REL: Reed 4PST 24 V 180 mA	175-1503
K7	REL: Reed 4PST 24 V 180 mA	175-1503
K8	REL: Reed 4PST 24 V 180 mA	175-1503
K9	REL: Reed 4PST 24 V 180 mA	175-1503
K10	REL: Reed 4PST 24 V 180 mA	175-1503
K11	REL: Reed 4PST 24 V 180 mA	175-1503
K12	REL: Reed 4PST 24 V 180 mA	175-1503
K13	REL: Reed 4PST 24 V 180 mA	175-1503

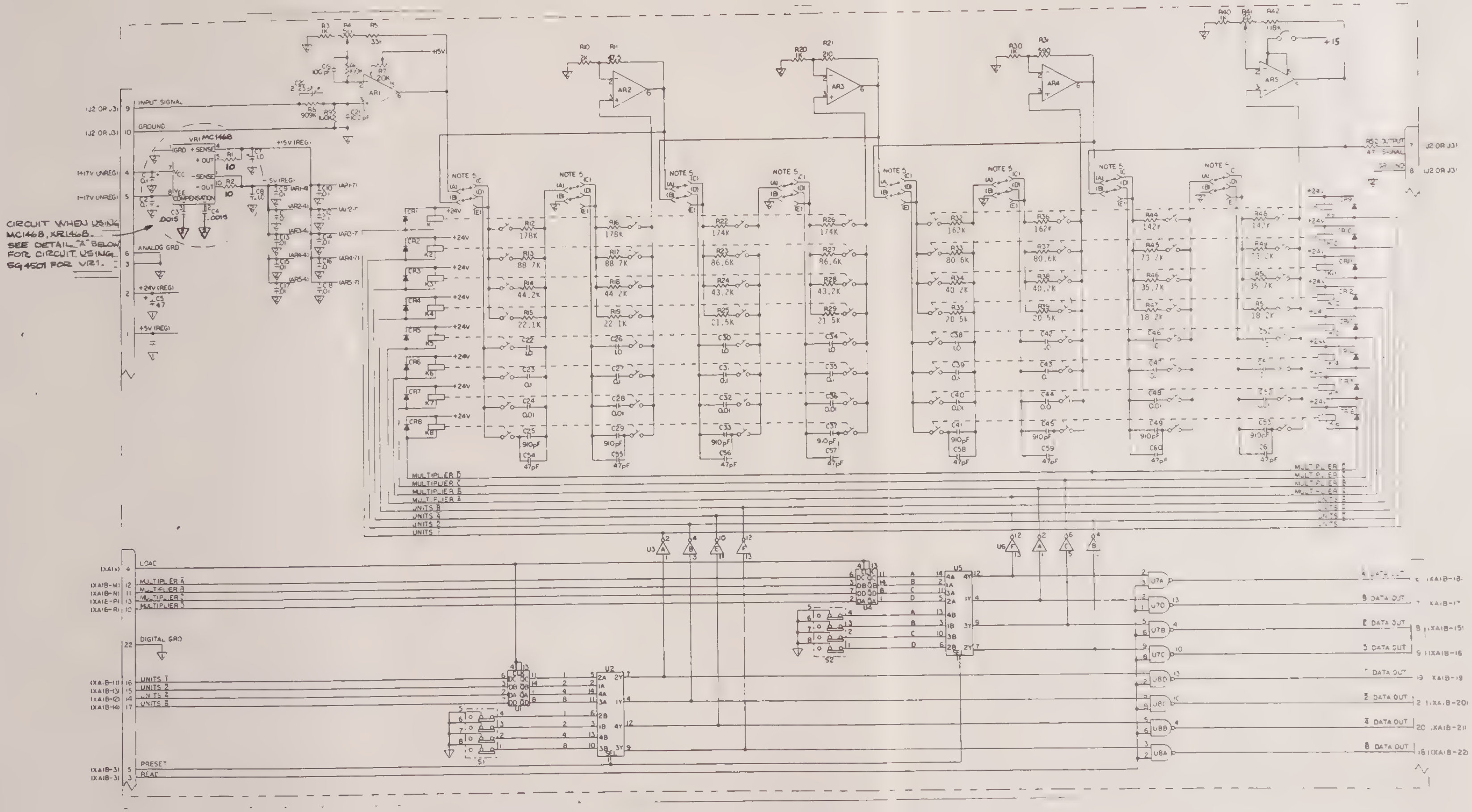
BUTTERWORTH 1 Hz-15 KHz FILTER ASSEMBLY (02) p.n. 004-0840 (cont)

REF. DES.	DESCRIPTION	PART NO.
K14	REL: Reed 4PST 24 V 180 mA	175-1503
K15	REL: Reed 4PST 24 V 180 mA	175-1503
K16	REL: Reed 4PST 24 V 180 mA	175-1503
R1	RES: Fxd comp 10 ohm 5% 1/4W	116-0101
R2	RES: Fxd comp 10 ohm 5% 1/4W	116-0101
R3	RES: Fxd metflm 1.00K 1% 1/8W	111-1000
R4	RES: Var cermet 50 ohm 10%	118-0500
R5	RES: Fxd metflm 453 ohm 1% 1/8W	110-4530
R6	RES: Fxd metflm 100K 1% 1/8W	113-1000
R7	RES: Var cermet 20K 10% 3/4W	118-3200
R8	RES: Fxd metflm 909K 1% 1/8W	113-9090
R9	RES: Fxd metflm 100K 1% 1/8W	113-1000
R10	RES: Fxd metflm 1.50K 1% 1/8W	111-1500
R11	RES: Fxd metflm 57.6 ohm 1% 1/8W	119-5760
R12	RES: Fxd metflm 159K 1% 1/8W	113-1590
R13	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R14	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R15	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R16	RES: Fxd metflm 159K 1% 1/8W	113-1590
R17	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R18	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R19	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R20	RES: Fxd metflm 1.00K 1% 1/8W	111-1000
R21	RES: Fxd metflm 340 ohm 1% 1/8W	110-3400
R22	RES: Fxd metflm 159K 1% 1/8W	113-1590
R23	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R24	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R25	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R26	RES: Fxd metflm 159K 1% 1/8W	113-1590
R27	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R28	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R29	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R30	RES: Fxd metflm 1.00K 1% 1/8W	111-1000
R31	RES: Fxd metflm 887 ohm 1% 1/8W	110-8870
R32	RES: Fxd metflm 159K 1% 1/8W	113-1590
R33	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R34	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R35	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R36	RES: Fxd metflm 159K 1% 1/8W	113-1590
R37	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R38	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R39	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R40	RES: Fxd metflm 1.00K 1% 1/8W	111-1000
R41	RES: Var cermet 20 ohm 10%	118-0200
R42	RES: Fxd metflm 1.62K 1% 1/8W	111-1620
R43	RES: Var cermet 20K 10% 3/4W	118-3200
R44	RES: Fxd metflm 159K 1% 1/8W	113-1590
R45	RES: Fxd metflm 79.6K 1% 1/8W	112-7960

BUTTERWORTH 1 Hz-15 KHz FILTER ASSEMBLY (02) p.n. 004-0840 (cont)

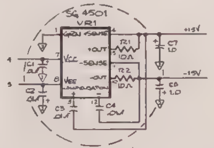
REF. DES.	DESCRIPTION	PART NO.
R46	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R47	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R48	RES: Fxd metflm 159K 1% 1/8W	113-1590
R49	RES: Fxd metflm 79.6K 1% 1/8W	112-7960
R50	RES: Fxd metflm 39.8K 1% 1/8W	112-3980
R51	RES: Fxd metflm 19.9K 1% 1/8W	112-1990
R52	RES: Fxd comp 47 ohm 5% 1/4W	116-0471
S1	SW: Slide SPST X4	342-4100
S2	SW: Slide SPST X4	342-4100
U1	IC: Quad Bistable latch	122-7475
U2	IC: Quad 2-input Data Sel/MLPX	122-0112
U3	IC: Hex inverter buffer/driver O/C	122-7406
U4	IC: Quad Bistable latch	122-7475
U5	IC: Quad 2-input Data Sel/MLPX	122-0112
U6	IC: Hex inverter buffer/driver O/C	122-7406
U7	IC: Quad 2-input NAND O/C	122-7401
U8	IC: Quad 2-input NAND O/C	122-7401
VR1	REG: Dual ± 15 volt 100 mA	120-0152
	Serial Number Label	371-1000
	IC Socket (For AR2)	353-0801
	IC Socket (For AR3)	353-0801
	IC Socket (For AR4)	353-0801
	IC Socket (For AR5)	353-0801

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A				



INPUT SIGNAL
GROUND
VR1 MC1468
+15V (REG)
-15V (REG)
COMPENSATION
ANALOG GRD
+24V (REG)
+5V (REG)
CIRCUIT WHEN USING MC1468, XR1468. SEE DETAIL "A" BELOW FOR CIRCUIT USING SG4501 FOR VR1.
AR1
AR2
AR3
AR4
AR5
NOTE 5
OUTPUT SIGNAL
SIGNAL GND
MULTIPLIER D
MULTIPLIER C
MULTIPLIER B
MULTIPLIER A
UNITS 8
UNITS 4
UNITS 2
UNITS 1
LOAD
DIGITAL GRD
PRESET
READ
U1
U2
U3
U4
U5
U6
U7A
U7B
U7C
U7D
U8A
U8B
U8C
U8D
S1
S2
A DATA OUT
B DATA OUT
C DATA OUT
D DATA OUT
1 DATA OUT
2 DATA OUT
4 DATA OUT
8 DATA OUT

6-STANDARD IC USED FOR VR1 IS A MC1468, XR1468. WHEN USING SG4501 IN THE VR1 POSITION, NOTE THE VALUE CHANGE OF C3 & C4 AND CIRCUITRY CHANGE.



SG4501
VR1
+15V
-15V

DETAIL "A"

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.

2. JUMPERS ARE SHOWN IN LOW PASS CONFIGURATION. PIN A TO PIN C AND PIN B TO PIN D. FOR HIGH-PASS CONFIGURATION CONNECT PIN A TO PIN D AND PIN B TO PIN E. ALL JUMPERS MUST BE CONNECTED THE SAME WAY.

HIGHEST REF DESIG USED:
AR5 C63 CR16 K16 R54 S2 U8 VR1

IC REF DES	
U1	122-7475
U2	0112
U3	7406
U4	7475
U5	0112
U6	7406
U7	7401
U8	122 7401

DRAWN BY
CHECKED BY:
ENG APPVL
MFG APPVL.

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

ROCKLAND
Rockland Systems Corporation

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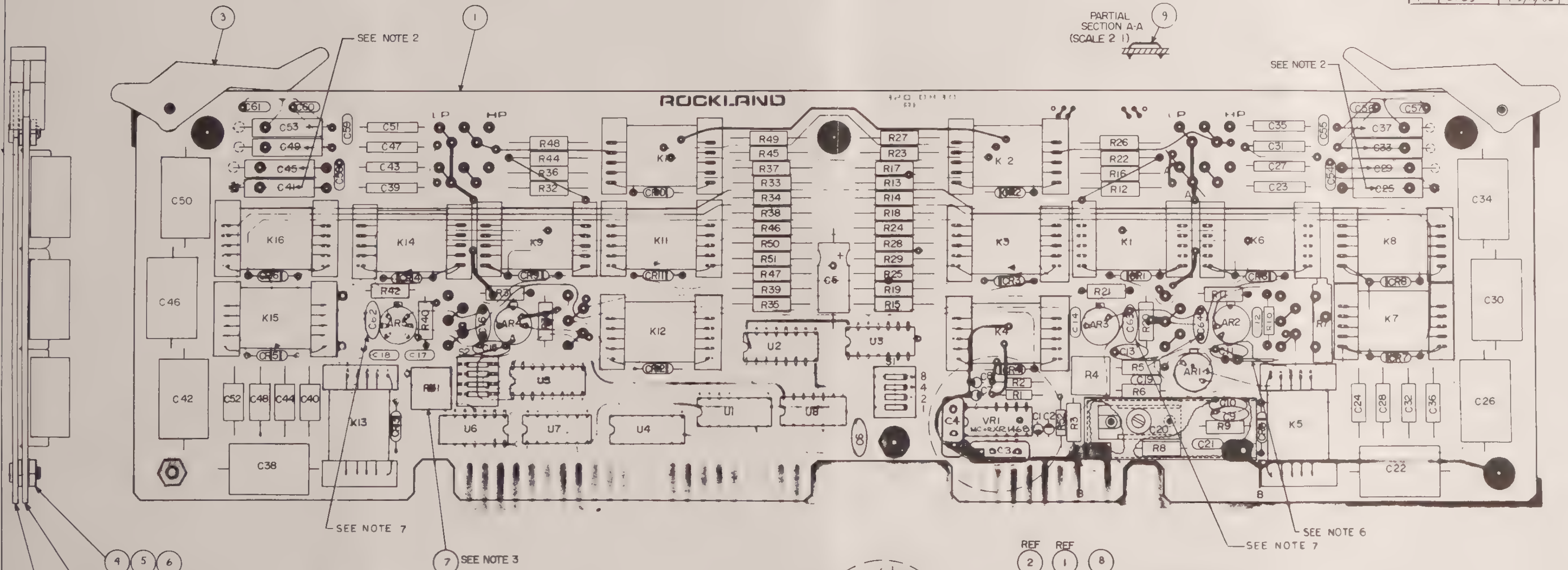
TITLE
SCHEMATIC DIAGRAM
FILTER CARD
BESSEL 1Hz-15KHz

SIZE D 03 DRAWING NO. 004-0845 REV A
SCALE N/A SHEET 1 OF 1

MAKE FROM 004-0F30 REV E

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
C	157	ARJ	RHH	9/5/74
D	[illegible]	[illegible]	RHH	5/28/75
E	455	WNT [illegible]	[illegible]	7-2-[illegible]
F	[illegible]	WNT [illegible]	[illegible]	1/25/77
G	914	[illegible] 4 11 8	[illegible]	5-20/[illegible]
H	336	[illegible]	[illegible]	[illegible]
J	1015	[illegible] 3-27-79	[illegible]	4/6/79
K	1132	5-21-80 [illegible]	[illegible]	5/22/80
L	1154	SM 12/11/80	[illegible]	2/16 81
M	[illegible]69	[illegible] 2/20/81	RHH	2/20/81
N	2085	SR 2/6/86	[illegible]	2/6/86
P	2135	NP 5/19/86	DM	5/19/86


③
SEE NOTE 2
①
PARTIAL
SECTION A-A
(SCALE 2:1)
⑨
SEE NOTE 2
ROCKLAND
C61
C60
C53
C49
C45
C41
C59
C58
C51
C47
C43
C39
LP
HP
R48
R44
R36
R32
K10
CR10
R49
R45
R37
R33
R34
R38
R46
R50
R51
R47
R39
R35
R27
R23
R17
R13
R14
R18
R24
R28
R29
R25
R19
R15
K2
CR2
R26
R22
R16
R12
C35
C31
C27
C23
C55
C54
C56
C57
C37
C33
C29
C25
C50
C46
C42
C34
C30
C26
K16
K14
K9
K11
K3
K1
K6
K8
K15
K12
K4
K7
K13
K5
CR16
CR14
CR9
CR11
CR3
CR1
CR6
CR8
CR15
CR12
CR4
CR7
R42
R40
R41
R31
R30
R21
R20
R11
R10
R4
R5
R6
R7
R8
R9
R1
R2
R3
AR1
AR2
AR3
AR4
AR5
C62
C63
C64
C18
C17
C16
C14
C13
C19
C20
C21
C22
C10
C11
C12
C9
C8
C7
C6
C5
C4
C3
C1
C2
C52
C48
C44
C40
C38
C24
C28
C32
C36
S1
S2
U1
U2
U3
U4
U5
U6
U7
U8
VR1
MC-XR1468
Q6
8
4
2
1
B
B
SEE NOTE 7
⑦ SEE NOTE 3
SEE NOTE 6
SEE NOTE 7
④ ⑤ ⑥
① REF
②

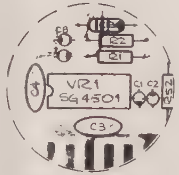
NOTES:

1. STAMP APPLICABLE ASSEMBLY PART NUMBER AND REVISION LETTER PER INK SPEC DRAWING NO. 00-995-0001.
2. C25, C29, C33, C37, C41, C45, C49, AND C53 MAY BE TYPE CM05 INSTEAD OF AS SHOWN. MOUNT CM05 TYPE CAPACITORS BETWEEN DASHED-OUTLINE PADS.
3. RANGE-MULTIPLIER LABEL ITEM 7 IS TRIMMED TO FIT R41. SELF ADHESIVE HOLDS LABEL IN PLACE AFTER R41 IS ADJUSTED. FOR

   004-0845 ASSEMBLY, TRIM LABEL TO SHOW X1, X10, X100, X1K.

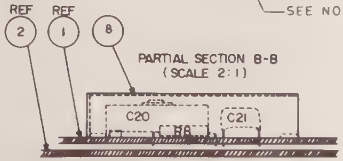
4. LEAD PROTRUSION THRU BOARD TO BE .062 MAX.
5. SHEETS 2 THRU 5 ARE "A" SIZE (L/M).
6. CONNECT JUMPER TO + SUPPLY FOR OP AMP # 120-1014
7. SELECT C62, C63, C64, IN TEST.

DETAIL "A"


C8
R2
R1
C4
VR1
SG 4501
C1 C2
R52
C3

STANDARD CONFIGURATION
VR1 IS MC1468 OR XR1468 (120-0152)
C3 & C4 ARE .0015 uf (105-2150)
REFER TO MAIN ASSY. DRAWING

ALTERNATE CONFIGURATION
VR1 IS SG 4501 (120-0157)
C3 & C4 ARE .01 uf (100-3101)
REFER TO DETAIL "A"


REF
REF
②
①
⑧
C20
R8
C21

PARTIAL SECTION B-B
(SCALE 2:1)

DRAWN BY ARJ	DATE 9/5/74	**ROCKLAND** Rockland Systems Corporation	
CHECKED BY RHH	9/11/74	Confidential property of ROCKLAND SYSTEMS CORP not to be disclosed to others reproduced or used for any purpose except as authorized in writing by above	
ENG APPVL RHH	9/11/74		
MFG APPVL BR	9/12/74		
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE .XXX ± .XX ± X/X ± 1/64 ∠° ± 1°		TITLE PCB ASSEMBLY, 1 Hz - 15 KHz BESSEL FILTER	
		SIZE D | 02 | 004-0845	REV P
		SCALE 2:1 | SHEET 1 OF 3	

BESSEL 1 Hz- 15 KHz FILTER ASSEMBLY (06) p.n. 004-0845

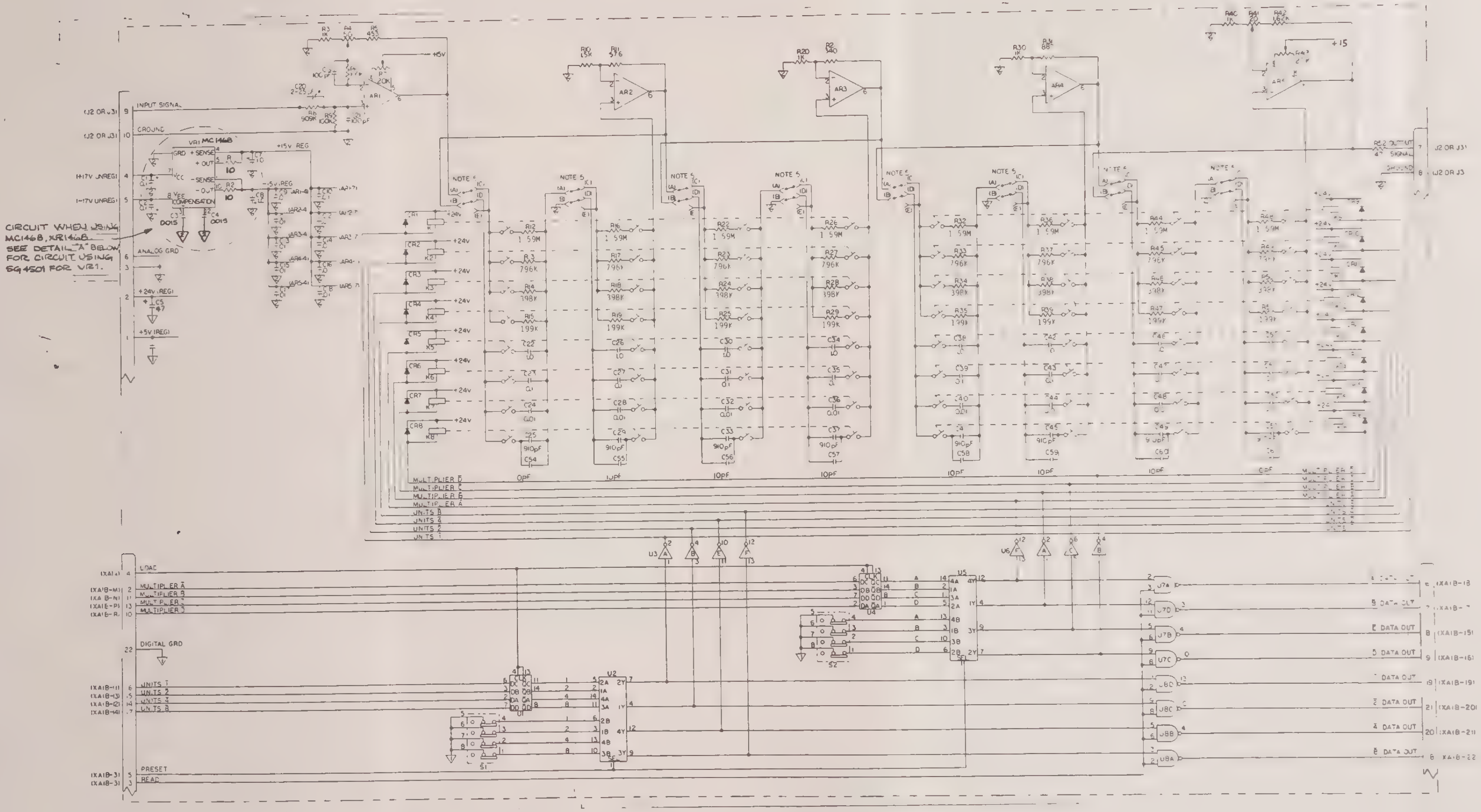
REF. DES.	DESCRIPTION	PART NO.
AR1	IC AMPL: Linear Op-Amp	120-1014
AR2	IC AMPL: Linear Op-Amp	120-1014
AR3	IC AMPL: Linear Op-Amp	120-1014
AR4	IC AMPL: Linear Op-Amp	120-1014
AR5	IC AMPL: Linear Op-Amp	120-1014
C1	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C2	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C3	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C4	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C5	CAP: Fxd elect 50uF 25 V	109-6500
C6	CAP: Fxd cer 0.1uF +80 -20% 15 V	100-4100
C7	CAP: Fxd tant 1uF 20% 35 V	109-5100
C8	CAP: Fxd tant 1uF 20% 35 V	109-5100
C9	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C10	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C11	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C12	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C13	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C14	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C15	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C16	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C17	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C18	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C19	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C20	CAP: Var mica 2-25pF 175 V	108-0250
C21	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C22	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C23	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C24	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C25	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C26	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C27	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C28	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C29	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C30	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C31	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C32	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C33	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C34	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C35	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C36	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C37	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C38	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C39	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C40	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C41	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C42	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C43	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100

BESSEL 1 Hz-15 KHz FILTER ASSEMBLY (06) p.n. 004-0845 (cont)

REF. DES.	DESCRIPTION	PART NO.
C44	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C45	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C46	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C47	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C48	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C49	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C50	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C51	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C52	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C53	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C54	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C55	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C56	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C57	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C58	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C59	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C60	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C61	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
CR1	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR2	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR3	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR4	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR5	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR6	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR7	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR8	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR9	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR10	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR11	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR12	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR13	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR14	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR15	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR16	DIO: Sil low leak 70 PIV 200 mA	132-0457
K1	REL: Reed 4PST 24 V 180 mA	175-1503
K2	REL: Reed 4PST 24 V 180 mA	175-1503
K3	REL: Reed 4PST 24 V 180 mA	175-1503
K4	REL: Reed 4PST 24 V 180 mA	175-1503
K5	REL: Reed 4PST 24 V 180 mA	175-1503
K6	REL: Reed 4PST 24 V 180 mA	175-1503
K7	REL: Reed 4PST 24 V 180 mA	175-1503
K8	REL: Reed 4PST 24 V 180 mA	175-1503
K9	REL: Reed 4PST 24 V 180 mA	175-1503
K10	REL: Reed 4PST 24 V 180 mA	175-1503
K11	REL: Reed 4PST 24 V 180 mA	175-1503
K12	REL: Reed 4PST 24 V 180 mA	175-1503
K13	REL: Reed 4PST 24 V 180 mA	175-1503
K14	REL: Reed 4PST 24 V 180 mA	175-1503

REF. DES.	DESCRIPTION	PART NO.
	BESSEL 1 Hz-15 KHz FILTER ASSEMBLY (06) p.n. 004-0845 (cont)	
R47	RES: Fxd metflm 18.2K 1% 1/8W	112-1820
R48	RES: Fxd metflm 143K 1% 1/8W	113-1430
R49	RES: Fxd metflm 73.2K 1% 1/8W	112-7320
R50	RES: Fxd metflm 35.7K 1% 1/8W	112-3570
R51	RES: Fxd metflm 18.2K 1% 1/8W	112-1820
R52	RES: Fxd comp 47 ohm 5% 1/4W	116-0471
S1	SW: Slide SPST X4	342-4100
S2	SW: Slide SPST X4	342-4100
U1	IC: Quad Bistable latch	122-7475
U2	IC: Quad 2-input Data Sel/MLPX	122-0112
U3	IC: Hex inverter buffer/driver O/C	122-7406
U4	IC: Quad Bistable latch	122-7475
U5	IC: Quad 2-input Data Sel/MLPX	122-0112
U6	IC: Hex inverter buffer/driver O/C	122-7406
U7	IC: Quad 2-input NAND O/C	122-7401
U8	IC: Quad 2-input NAND O/C	122-7401
VR1	REG: Dual ± 15 volt 100 mA	120-0152
	Serial Number Label	371-1000
	IC Socket (For AR2)	353-0801
	IC Socket (For AR3)	353-0801
	IC Socket (For AR4)	353-0801
	IC Socket (For AR5)	353-0801

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A				



CIRCUIT WHEN USING MC1468, XR1468. SEE DETAIL "A" BELOW FOR CIRCUIT USING SG4501 FOR VR1.

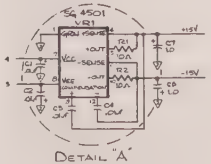
INPUT SIGNAL
GROUND
(J2 OR J3) 9
(J2 OR J3) 10
(+17V UNREG) 4
(-17V UNREG) 5
ANALOG GRD
+24V (REG)
+5V (REG)
VR1 MC1468
GRD
+SENSE
+OUT
-SENSE
-OUT
VCC
VEE
COMPENSATION
+15V REG
-15V REG
C3 .0015
C4 .0015
R3 1K
R5 453
C20 2-25
R6 909K
R9 100K
+15V
AR1
AR2
AR3
AR4
AR5
R10 1.5K
R11 576
R20 1K
R21 590
R30 1K
R31 681
+15
NOTE 5
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
K1
K2
K3
K4
K5
K6
K7
K8
+24V
R12 1.59M
R13 796K
R14 398K
R15 199K
R16 1.59M
R17 796K
R18 398K
R19 199K
R22 1.59M
R23 796K
R24 398K
R25 199K
R26 1.59M
R27 796K
R28 398K
R29 199K
R32 1.59M
R33 796K
R34 398K
R35 199K
R36 1.59M
R37 796K
R38 398K
R39 199K
R44 1.59M
R45 796K
R46 398K
R47 199K
910pF
10PF
C54
C55
C56
C57
C58
C59
R52 OUTPUT SIGNAL
GROUND
J2 OR J3
MULTIPLIER D
MULTIPLIER C
MULTIPLIER B
MULTIPLIER A
UNITS 8
UNITS 4
UNITS 2
UNITS 1
U3
U6
LOAD
(XA1-4) 4
MULTIPLIER A
MULTIPLIER B
MULTIPLIER C
MULTIPLIER D
(XA1B-M) 2
(XA1B-N) 11
(XA1E-P) 13
(XA1B-R) 10
DIGITAL GRD 22
UNITS 1
UNITS 2
UNITS 4
UNITS 8
(XA1B-11) 6
(XA1B-13) 5
(XA1B-12) 14
(XA1B-14) 7
PRESET
READ
(XA1B-3) 5
(XA1B-3) 3
U1
U2
U4
U5
S1
S2
U7A
U7B
U7C
U7D
U8A
U8B
U8C
U8D
DATA OUT
(XA1B-18)
(XA1B-15)
(XA1B-16)
(XA1B-19)
(XA1B-20)
(XA1B-21)
(XA1B-22)

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.

2. JUMPERS ARE SHOWN IN LOW PASS CONFIGURATION. PIN A TO PIN C AND PIN B TO PIN D. FOR HIGH-PASS CONFIGURATION CONNECT PIN A TO PIN D AND PIN B TO PIN E. ALL JUMPERS MUST BE CONNECTED THE SAME WAY.

6- STANDARD IC USED FOR VR1 IS A MC1468, XR1468. WHEN USING SG4501 IN THE VR1 POSITION; NOTE THE VALUE CHANGE OF C3 & C4 AND CIRCUITRY CHANGE.



SG 4501
VR1
GRD
+SENSE
+OUT
-SENSE
-OUT
VCC
VEE
COMPENSATION
R1 10Ω
R2 10Ω
C7 1.0
C8 1.0
C1 .1uF
C2 .1uF
C3 .1uF
C4 .01uF
+15V
-15V
4
5

DETAIL "A"

HIGHEST REF DESIG USED:
AR5 C63 CR16 K16 R54 S2 U8 VR1

IC REF DES	
U1	122-7475
U2	0112
U3	7406
U4	7475
U5	0112
U6	7406
U7	7401
U8	122 7401

DRAWN BY	DATE
CHECKED BY	
ENG APPVL	
MFG APPVL	

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UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

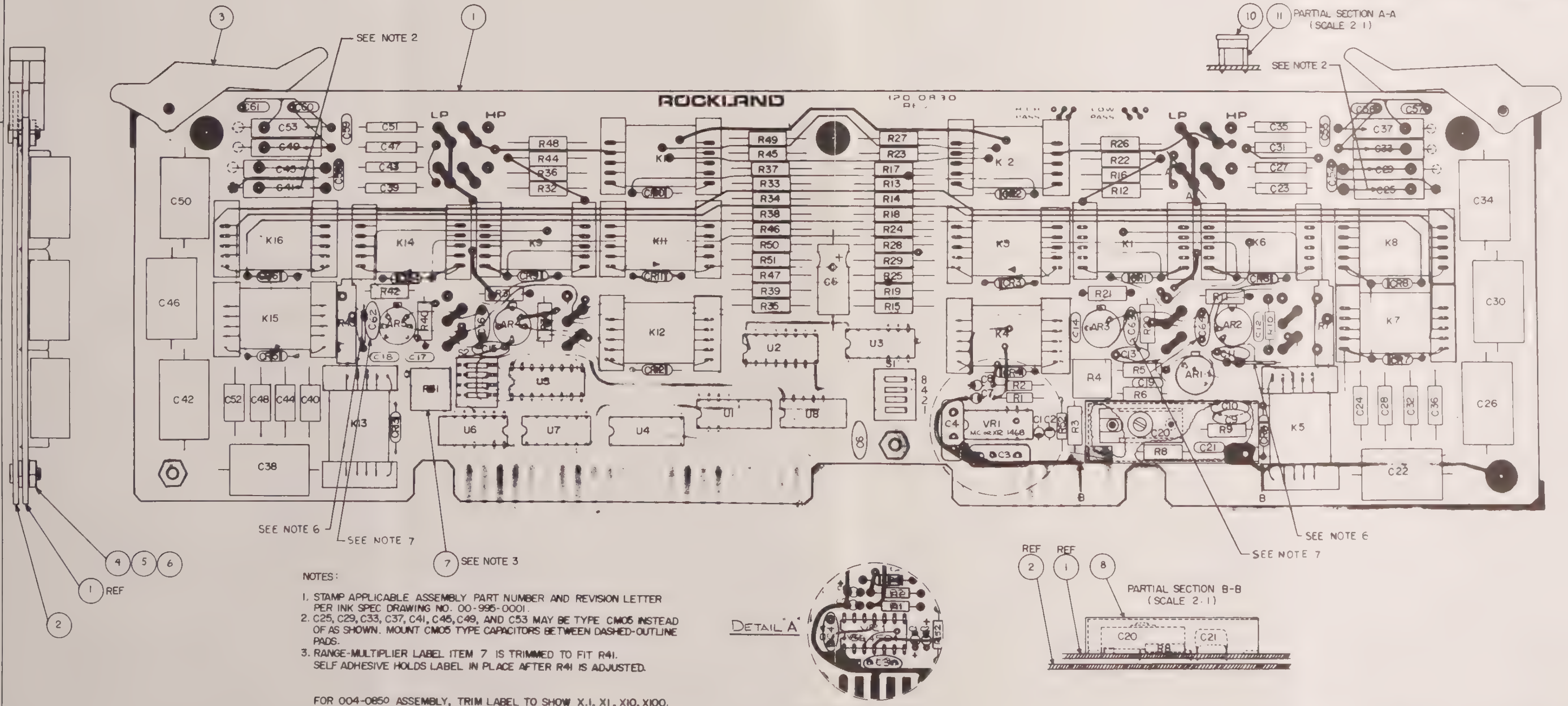
TITLE
SCHEMATIC DIAGRAM
FILTER CARD
BUTTERWORTH .1Hz-1.5KHz

SIZE		DRAWING NO.	REV
D	03	004-0850	A

SCALE
SHEET 1 OF 1

MAKE FROM

LTR	ECO NO.	CHANGED BY	APPV'D BY	DATE
C	157	HQJ	RHH	9/5/74
D	368	[illegible]	RHH	9/20/75
E	425	WNT [illegible]	RHH	7-2-76
F	[illegible]	WNT [illegible]	RHH	/24/77
G	[illegible]	[illegible] 4-11-78	RHH	[illegible]
H	330	[illegible]	RHH	[illegible]
J	1015	JB 3 21 79	RHH JV	4/2/79
K	1132	5 21 80	RHH JV	5/22/80
L	1154	SM 12/12/80	RHH	[illegible]
M	69	2/2/81	RHH JV	2/20/81
N	2236	[illegible]	[illegible]	7/19/85


3
1
SEE NOTE 2
ROCKLAND
120 0830
LP
HP
HIGH PASS
LOW PASS
10
11
PARTIAL SECTION A-A
(SCALE 2:1)
SEE NOTE 2
C61
C60
C53
C49
C45
C41
C51
C47
C43
C39
C50
C46
C42
C38
C52
C48
C44
C40
R48
R44
R36
R32
R49
R45
R37
R33
R34
R38
R46
R50
R51
R47
R39
R35
R27
R23
R17
R13
R14
R18
R24
R28
R29
R25
R19
R15
R26
R22
R16
R12
C35
C31
C27
C23
C37
C33
C29
C25
C58
C57
C34
C30
C26
C22
C24
C28
C32
C36
K16
K14
K9
K11
K10
K15
K12
K13
K2
K3
K1
K6
K8
K7
K4
K5
AR5
AR4
AR3
AR2
AR1
R42
R41
R40
C62
C63
C64
C18
C17
S2
S1
U1
U2
U3
U4
U5
U6
U7
U8
C6
C4
VR1
MC or XR 1468
C1
C2
C3
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R21
C5
C7
C8
C9
C10
C11
C12
C13
C14
C19
C20
C21
B
B
SEE NOTE 6
SEE NOTE 7
7 SEE NOTE 3
4 5 6
1 REF
2
SEE NOTE 6
SEE NOTE 7
REF 2
REF 1
8
PARTIAL SECTION B-B
(SCALE 2:1)
DETAIL "A"

NOTES:

1. STAMP APPLICABLE ASSEMBLY PART NUMBER AND REVISION LETTER PER INK SPEC DRAWING NO. 00-995-0001.
2. C25, C29, C33, C37, C41, C45, C49, AND C53 MAY BE TYPE CM05 INSTEAD OF AS SHOWN. MOUNT CM05 TYPE CAPACITORS BETWEEN DASHED-OUTLINE PADS.
3. RANGE-MULTIPLIER LABEL ITEM 7 IS TRIMMED TO FIT R41. SELF ADHESIVE HOLDS LABEL IN PLACE AFTER R41 IS ADJUSTED.

   FOR 004-0850 ASSEMBLY, TRIM LABEL TO SHOW X.1, X1, X10, X100.

4. LEAD PROTRUSION THRU BOARD TO BE .062 MAX.
5. SHEETS 2 THRU 5 ARE "A" SIZE (L/M).
6. CONNECT JUMPER TO + SUPPLY FOR OP AMP # 120-1014
7. SELECT C62, C63, C64, IN TEST.

STANDARD CONFIGURATION

VR1 IS MC1468 OR XR1468 (120-0152)
C3:C4 ARE .0015 µf (105-2150)
REFER TO MAIN ASS'Y. DRAWING.

ALTERNATE CONFIGURATION

VR1 IS SG 4501 (120-0157)
C3:C4 ARE .01 µf (100-3101)
REFER TO DETAIL "A"

DRAWN BY	HQJ	DATE 9/5/74	**ROCKLAND** Rockland Systems Corporation
CHECKED BY	RHH	9/11/74	Confidential property of ROCKLAND SYSTEMS CORP not to be disclosed to others reproduced or used for any purpose except as authorized in writing by above
ENG APPVL	RHH	9/11/74	
MFG APPVL	B R	9/12/74	
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE XXX ± XX ± X/X ± 1/64 ∠° ± 1°			TITLE PCB ASSEMBLY, 0.1 Hz – 1.5 KHz BUTTERWORTH FILTER
SIZE D	02	DRAWING NO 004-0850	REV N
SCALE 2:1		SHEET 1 OF 5	

BUTTERWORTH 0.1 Hz-1.5 KHz FILTER ASSEMBLY (03) p.n. 004-0850

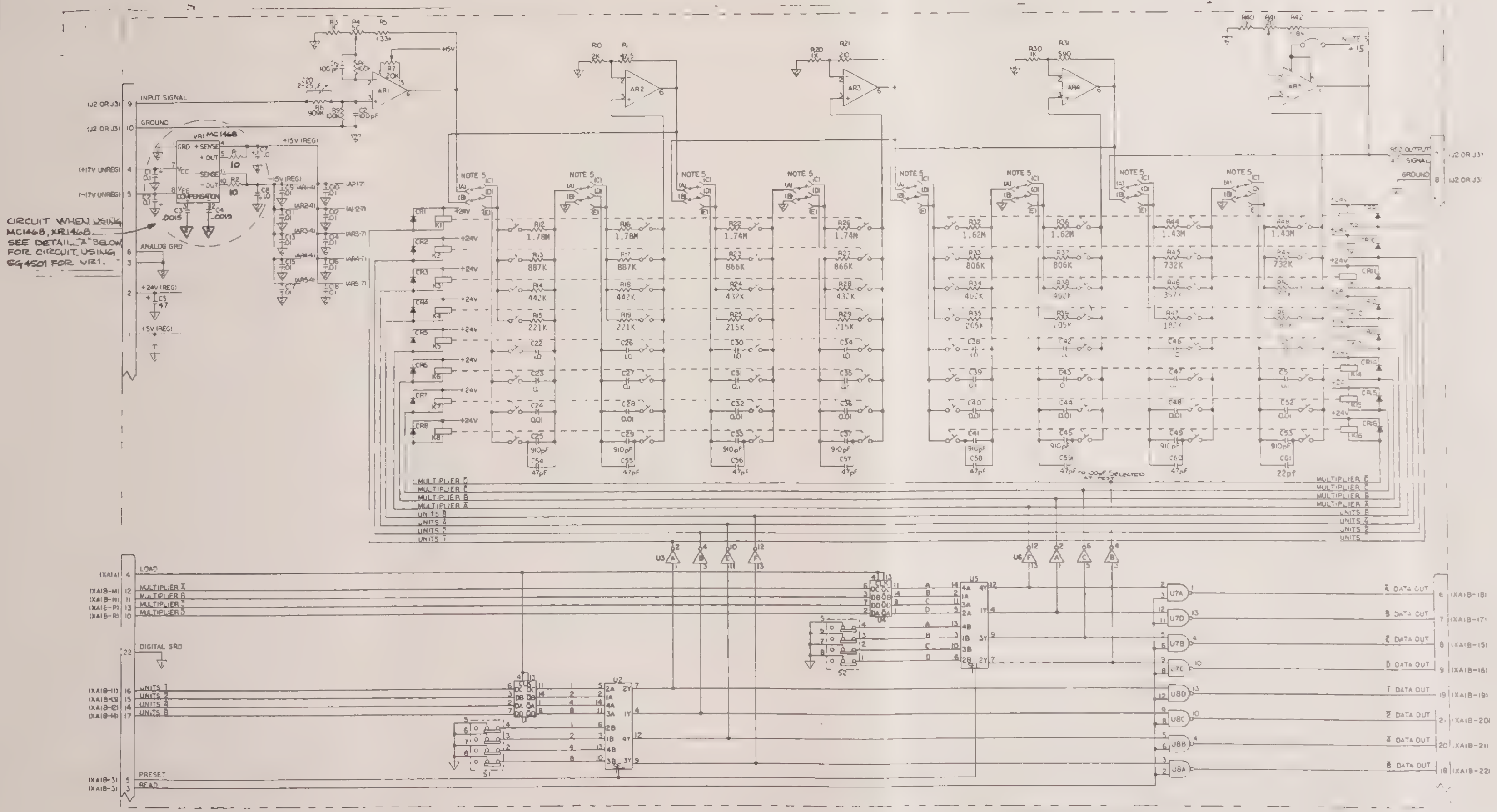
REF. DES.	DESCRIPTION	PART NO.
AR1	IC AMPL: Linear Op-Amp	120-1014
AR2	IC AMPL: Linear Op-Amp	120-1014
AR3	IC AMPL: Linear Op-Amp	120-1014
AR4	IC AMPL: Linear Op-Amp	120-1014
AR5	IC AMPL: Linear Op-Amp	120-1014
C1	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C2	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C3	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C4	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C5	CAP: Fxd elect 50uF 25 V	109-6500
C6	CAP: Fxd cer 0.1uF +80 -20% 15 V	100-4100
C7	CAP: Fxd tant 1uF 20% 35 V	109-5100
C8	CAP: Fxd tant 1uF 20% 35 V	109-5100
C9	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C10	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C11	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C12	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C13	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C14	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C15	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C16	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C17	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C18	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C19	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C20	CAP: Var mica 2-25pF 175 V	108-0250
C21	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C22	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C23	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C24	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C25	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C26	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C27	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C28	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C29	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C30	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C31	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C32	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C33	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C34	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C35	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C36	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C37	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C38	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C39	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C40	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C41	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C42	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C43	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100

BUTTERWORTH 0.1 Hz-1.5 KHz FILTER ASSEMBLY (03) p.n. 004-0850 (cont)

REF. DES.	DESCRIPTION	PART NO.
C44	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C45	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C46	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C47	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C48	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C49	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C50	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C51	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C52	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C53	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C54	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C55	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C56	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C57	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C58	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C59	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C60	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
C61	CAP: Fxd mica dipped 10 pF 10% 500V	101-0100
CR1	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR2	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR3	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR4	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR5	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR6	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR7	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR8	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR9	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR10	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR11	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR12	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR13	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR14	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR15	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR16	DIO: Sil low leak 70 PIV 200 mA	132-0457
K1	REL: Reed 4PST 24 V 180 mA	175-1503
K2	REL: Reed 4PST 24 V 180 mA	175-1503
K3	REL: Reed 4PST 24 V 180 mA	175-1503
K4	REL: Reed 4PST 24 V 180 mA	175-1503
K5	REL: Reed 4PST 24 V 180 mA	175-1503
K6	REL: Reed 4PST 24 V 180 mA	175-1503
K7	REL: Reed 4PST 24 V 180 mA	175-1503
K8	REL: Reed 4PST 24 V 180 mA	175-1503
K9	REL: Reed 4PST 24 V 180 mA	175-1503
K10	REL: Reed 4PST 24 V 180 mA	175-1503
K11	REL: Reed 4PST 24 V 180 mA	175-1503
K12	REL: Reed 4PST 24 V 180 mA	175-1503
K13	REL: Reed 4PST 24 V 180 mA	175-1503
K14	REL: Reed 4PST 24 V 180 mA	175-1503

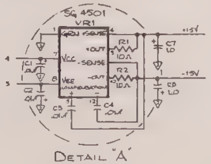
REF. DES.	DESCRIPTION	PART NO.
	BUTTERWORTH 0.1 Hz-1.5 KHz FILTER ASSEMBLY (03) p.n. 004-0850 (cont)	
R47	RES: Fxd metflm 199K 1% 1/8W	113-1990
R48	RES: Fxd metflm 1.59M 1% 1/8W	114-1590
R49	RES: Fxd metflm 796K 1% 1/8W	113-7960
R50	RES: Fxd metflm 398K 1% 1/8W	113-3980
R51	RES: Fxd metflm 199K 1% 1/8W	113-1990
R52	RES: Fxd comp 47 ohm 5% 1/4W	116-0471
S1	SW: Slide SPST X4	342-4100
S2	SW: Slide SPST X4	342-4100
U1	IC: Quad Bistable latch	122-7475
U2	IC: Quad 2-input Data Sel/MLPX	122-0112
U3	IC: Hex inverter buffer/driver O/C	122-7406
U4	IC: Quad Bistable latch	122-7475
U5	IC: Quad 2-input Data Sel/MLPX	122-0112
U6	IC: Hex inverter buffer/driver O/C	122-7406
U7	IC: Quad 2-input NAND O/C	122-7401
U8	IC: Quad 2-input NAND O/C	122-7401
VR1	REG: Dual ± 15 volt 100 mA	120-0152
	Serial Number Label	371-1000
	IC Socket (For AR2)	353-0801
	IC Socket (For AR3)	353-0801
	IC Socket (For AR4)	353-0801
	IC Socket (For AR5)	353-0801

LTR	ECO NO	CHANGED BY	APPV'D BY	DATE
A	RELEASE	SD 11-12-86		



CIRCUIT WHEN USING MC1468, XR1468. SEE DETAIL "A" BELOW FOR CIRCUIT USING SG4501 FOR VR1.
INPUT SIGNAL
GROUND
(J2 OR J3) 9
(J2 OR J3) 10
(+17V UNREG) 4
(−17V UNREG) 5
ANALOG GRD
+24V (REG)
+5V (REG)
VR1 MC1468
+15V (REG)
−15V (REG)
COMPENSATION
AR1
AR2
AR3
AR4
AR5
NOTE 5
R12 1.78M
R13 887K
R14 442K
R15 221K
R16 1.78M
R17 887K
R18 442K
R19 221K
R22 1.74M
R23 866K
R24 432K
R25 215K
R26 1.74M
R27 866K
R28 432K
R29 215K
R32 1.62M
R33 806K
R34 402K
R35 205K
R36 1.62M
R37 806K
R38 402K
R39 205K
R44 1.43M
R45 732K
R46 357K
R47 182K
R48 1.43M
R49 732K
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
+24V
910pF
47pF
22pF
MULTIPLIER D
MULTIPLIER C
MULTIPLIER B
MULTIPLIER A
UNITS 8
UNITS 4
UNITS 2
UNITS 1
OUTPUT SIGNAL
GROUND
(J2 OR J3)
LOAD
MULTIPLIER 1
MULTIPLIER 2
MULTIPLIER 4
MULTIPLIER 8
DIGITAL GRD
UNITS 1
UNITS 2
UNITS 4
UNITS 8
PRESET
READ
(XA1A) 4
(XA1B-M) 12
(XA1B-N) 11
(XA1B-P) 13
(XA1B-R) 10
(XA1B-11) 16
(XA1B-12) 15
(XA1B-13) 14
(XA1B-14) 17
(XA1B-3) 5
(XA1B-3) 3
U1
U2
U3
U4
U5
U6
S1
S2
U7A
U7D
U7B
U7C
U8D
U8C
U8B
U8A
A DATA OUT
B DATA OUT
C DATA OUT
D DATA OUT
1 DATA OUT
2 DATA OUT
4 DATA OUT
8 DATA OUT
(XA1B-18)
(XA1B-17)
(XA1B-15)
(XA1B-16)
(XA1B-19)
(XA1B-20)
(XA1B-21)
(XA1B-22)

6.- STANDARD IC USED FOR VR1 IS A MC1468, XR1468. WHEN USING SG4501 IN THE VR1 POSITION; NOTE THE VALUE CHANGE OF C3 & C4 AND CIRCUITRY CHANGE.



SG 4501
VR1
GRD
+SENSE
+OUT
−SENSE
−OUT
VCC
VEE
COMPENSATION
R1 10Ω
R2 10Ω
C1 .01
C2 .01
C3 .01
C4 .01
C7 1.0
C8 1.0
+15V
−15V
4
5

DETAIL "A"

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS. ALL CAPACITOR VALUES ARE IN MICROFARADS.

2. JUMPERS ARE SHOWN IN LOW PASS CONFIGURATION. PIN A TO PIN C AND PIN B TO PIN D, FOR HIGH-PASS CONFIGURATION. CONNECT PIN A TO PIN D AND PIN B TO PIN E. ALL JUMPERS MUST BE CONNECTED THE SAME WAY.

HIGHEST REF DESIG USED.
AR5 C63 CR16 K16 R54 S2 U8 VR1

IC REF DES	
U1	122-7475
U2	0112
U3	7406
U4	7475
U5	0112
U6	7406
U7	7401
U8	122 7401

DRAWN BY	DATE
CHECKED BY	11 14 84
ENG APPVL.	11/14/84
MFG APPVL.	

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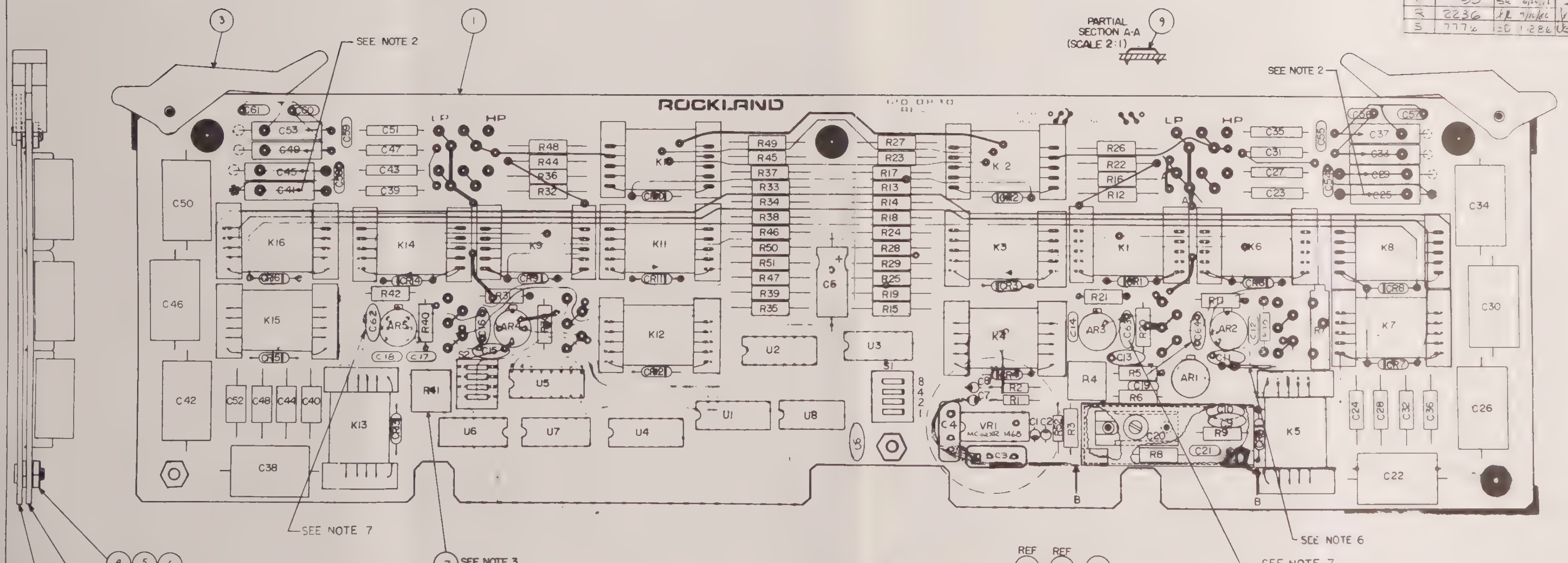
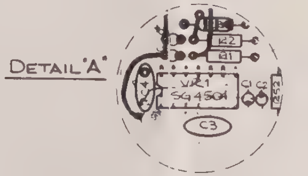
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE:
.XXX ±
.XX ±
X/X ± 1/64
∠° ± 1°

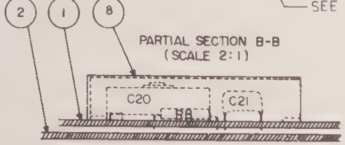
TITLE
SCHEMATIC DIAGRAM
FILTER CARD
BESSEL .1Hz − 1.5KHz

SIZE D 03 DRAWING NO. 004-0855 REV A
SCALE SHEET 1 OF 1

[illegible]	[illegible]	[illegible]		
C	157	[illegible]	RAH	[illegible]
D	269	[illegible]	RAH	[illegible]
E	455	WHT 6/17/76	[illegible]	[illegible]
F	7?5?	WH 12/17/76	[illegible]	[illegible]
G	914	SJS 4-11-78	[illegible]	[illegible]
H	936	TH [illegible]	[illegible]	[illegible]
J	1015	LB 3-27-79	[illegible]	[illegible]
K	1132	5208 3A1A	[illegible]	[illegible]
L	1154	SM 2/12/80	[illegible]	[illegible]
M	1169	RAH 2/21/81	RAH	[illegible]
N	1770	KW 2/29/84		
P	[illegible]	SG [illegible]	[illegible]	[illegible]
R	2236	[illegible] 9/16/86	[illegible]	[illegible] 9/26
S	777?	ED 11-2-86	[illegible]	11/4/86


PARTIAL SECTION A-A (SCALE 2:1)
9
3
1
SEE NOTE 2
SEE NOTE 2
ROCKLAND
LP
HP
LP
HP
C61
C60
C53
C49
C45
C41
C59
C51
C47
C43
C39
R48
R44
R36
R32
K10
R49
R45
R37
R33
R34
R38
R46
R50
R51
R47
R39
R35
R27
R23
R17
R13
R14
R18
R24
R28
R29
R25
R19
R15
K2
R26
R22
R16
R12
C35
C31
C27
C23
C55
C58
C57
C37
C33
C29
C25
C54
C50
C34
K16
K14
K9
K11
C6
K3
K1
K6
K8
CR16
CR14
CR9
CR11
CR10
CR12
CR3
CR1
CR6
CR8
C46
K15
R42
AR5
C62
R40
C16
AR4
R43
K12
U2
U3
K4
R21
AR3
C14
C63
R11
AR2
C64
C12
R7
K7
C30
CR15
C18
C17
S2
C15
CR12
U5
S1
8 4 2 1
R4
C13
R5
R6
AR1
CR7
C42
C52
C48
C44
C40
R41
K13
CR13
U6
U7
U4
U1
U8
U9
VR1
MC1468 XR 1468
C4
C7
C8
R2
R1
C1
C2
R3
C19
C20
C10
C9
R9
R8
C21
C3
K5
C24
C28
C32
C36
C26
C38
C22
B
B
SEE NOTE 7
SEE NOTE 6
SEE NOTE 7
7 SEE NOTE 3
4 5 6
1 REF
2


DETAIL "A"
R2
R1
VR1
SG4501
C1
C2
C4
C3


REF
REF
2
1
8
PARTIAL SECTION B-B
(SCALE 2:1)
C20
C21
R8

NOTES:

1. STAMP APPLICABLE ASSEMBLY PART NUMBER AND REVISION LETTER PER INK SPEC DRAWING NO. 00-995-0001.
2. C25, C29, C33, C37, C41, C45, C49, AND C53 MAY BE TYPE CM05 INSTEAD OF AS SHOWN. MOUNT CM05 TYPE CAPACITORS BETWEEN DASHED-OUTLINE PADS.
3. RANGE-MULTIPLIER LABEL ITEM 7 IS TRIMMED TO FIT R41. SELF ADHESIVE HOLDS LABEL IN PLACE AFTER R41 IS ADJUSTED.

   FOR 004-0855 ASSEMBLY, TRIM LABEL TO SHOW X.1, X1, X10, X100.

4. LEAD PROTRUSION THRU BOARD TO BE .062 MAX.
5. SHEETS 2 THRU 5 ARE "A" SIZE (L/M).
6. CONNECT JUMPER TO + SUPPLY FOR OP AMP # 120-101[illegible]
7. SELECT C62, C63, C64, IN TEST.

STANDARD CONFIGURATION

VR1 IS MC1468 OR XR1468 (120-0152)
C3 & C4 ARE .0015uf (105-2150)
REFER TO MAIN ASSY. DRAWING.

ALTERNATE CONFIGURATION

VR1 IS SG4501 (120-0157)
C3 & C4 ARE .01uf (100-3101)
REFER TO DETAIL "A"

DRAWN BY	ARL	DATE 9/5/74	**ROCKLAND** Rockland Systems Corporation
CHECKED BY	RAH	9/11/74	Confidential property of ROCKLAND SYSTEMS CORP not to be disclosed to others, reproduced or used for any purpose except as authorized in writing by above
ENG APPVL.	RAH	9/11/74	
MFG APPVL.	B.R.	9/12/74	
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AFTER FINISHING AND TOLERANCES ARE .XXX ± .XX ± FR/X ± 1/64 ∠° ± 1°			TITLE PCB ASSEMBLY, 0.1 Hz - 1.5KHz BESSEL FILTER
SIZE D	DRAWING NO. 02 004-0855	SCALE 2:1	SHEET 1 OF 5 · REV S

BESSEL 0.1 Hz-1.5 KHz FILTER ASSEMBLY (07) p.n. 004-0855

REF. DES.	DESCRIPTION	PART NO.
AR1	IC AMPL: Linear Op-Amp	120-1014
AR2	IC AMPL: Linear Op-Amp	120-1014
AR3	IC AMPL: Linear Op-Amp	120-1014
AR4	IC AMPL: Linear Op-Amp	120-1014
AR5	IC AMPL: Linear Op-Amp	120-1014
C1	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C2	CAP: Fxd tant 0.1uF 20% 35 V	109-4100
C3	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C4	CAP: Fxd polyester 0.0015uF 10% 100 V	105-2150
C5	CAP: Fxd elect 50uF 25 V	109-6500
C6	CAP: Fxd cer 0.1uF +80 -20% 15 V	100-4100
C7	CAP: Fxd tant 1uF 20% 35 V	109-5100
C8	CAP: Fxd tant 1uF 20% 35 V	109-5100
C9	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C10	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C11	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C12	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C13	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C14	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C15	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C16	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C17	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C18	CAP: Fxd cer 0 . 01uF +80 -20% 30 V	100-3101
C19	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C20	CAP: Var mica 2-25pF 175 V	108-0250
C21	CAP: Fxd mica dipped 100pF 10% 500 V	101-1100
C22	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C23	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C24	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C25	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C26	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C27	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C28	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C29	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C30	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C31	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C32	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C33	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C34	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C35	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C36	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C37	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C38	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C39	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C40	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C41	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C42	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C43	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C44	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100

BESSEL 0.1 Hz-1.5 KHz FILTER ASSEMBLY (07) p.n. 004-0855 (cont)

REF. DES.	DESCRIPTION	PART NO.
C45	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C46	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C47	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C48	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C49	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C50	CAP: Fxd polycarb molded 1uF 1% 100 V	104-5100
C51	CAP: Fxd polycarb molded 0.1uF 1% 100 V	104-4100
C52	CAP: Fxd polycarb molded 0.01uF 1% 100 V	104-3100
C53	CAP: Fxd mica molded 910pF 1% 500 V	102-1910
C54	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C55	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C56	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C57	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C58	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C59	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C60	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
C61	CAP: Fxd mica dipped 47pF 10% 500 V	101-0470
CR1	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR2	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR3	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR4	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR5	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR6	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR7	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR8	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR9	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR10	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR11	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR12	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR13	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR14	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR15	DIO: Sil low leak 70 PIV 200 mA	132-0457
CR16	DIO: Sil low leak 70 PIV 200 mA	132-0457
K1	REL: Reed 4PST 24 V 180 mA	175-1503
K2	REL: Reed 4PST 24 V 180 mA	175-1503
K3	REL: Reed 4PST 24 V 180 mA	175-1503
K4	REL: Reed 4PST 24 V 180 mA	175-1503
K5	REL: Reed 4PST 24 V 180 mA	175-1503
K6	REL: Reed 4PST 24 V 180 mA	175-1503
K7	REL: Reed 4PST 24 V 180 mA	175-1503
K8	REL: Reed 4PST 24 V 180 mA	175-1503
K9	REL: Reed 4PST 24 V 180 mA	175-1503
K10	REL: Reed 4PST 24 V 180 mA	175-1503
K11	REL: Reed 4PST 24 V 180 mA	175-1503
K12	REL: Reed 4PST 24 V 180 mA	175-1503
K13	REL: Reed 4PST 24 V 180 mA	175-1503
K14	REL: Reed 4PST 24 V 180 mA	175-1503

REF. DES.	DESCRIPTION	PART NO.
	BESSEL 0.1 Hz-1.5 KHz FILTER ASSEMBLY (07) p.n. 004-0855 (cont)	
R47	RES: Fxd metflm 182K 1% 1/8W	113-1820
R48	RES: Fxd metflm 1.43M 1% 1/8W	114-1430
R49	RES: Fxd metflm 732K 1% 1/8W	113-7320
R50	RES: Fxd metflm 357K 1% 1/8W	113-3570
R51	RES: Fxd metflm 182K 1% 1/8W	113-1820
R52	RES: Fxd comp 47 ohm 5% 1/4W	116-0471
S1	SW: Slide SPST X4	342-4100
S2	SW: Slide SPST X4	342-4100
U1	IC: Quad Bistable latch	122-7475
U2	IC: Quad 2-input Data Sel/MLPX	122-0112
U3	IC: Hex inverter buffer/driver O/C	122-7406
U4	IC: Quad Bistable latch	122-7475
U5	IC: Quad 2-input Data Sel/MLPX	122-0112
U6	IC: Hex inverter buffer/driver O/C	122-7406
U7	IC: Quad 2-input NAND O/C	122-7401
U8	IC: Quad 2-input NAND O/C	122-7401
VR1	REG: Dual ± 15 volt 100 mA	120-0152
	Serial Number Label	371-1000
	IC Socket (For AR2)	353-0801
	IC Socket (For AR3)	353-0801
	IC Socket (For AR4)	353-0801
	IC Socket (For AR5)	353-0801

REV	ECN	BY	DATE	APP

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	CLAMP: CABLE NYLON 1/4"	773	SMITH	362.1603	4
NONE	CLAMP: CABLE NYLON 1/2"	8961	SMITH	362.1604	4
NONE	CLAMP: CABLE NYLON 1"	783	SMITH	362.1605	4
NONE	M SCR: ST CD SL 8-32 X 3/8PH			380.8062	4
NONE	WASHER: FLAT STL CAD #8			388.0080	4
NONE	SPR: THD 3/8HX 8-32X1	1452E	KEYST	389.2003	4

WAVETEK
PARTS LIST

TITLE
STRAIN RELIEF KIT 816

ASSEMBLY NO. 002.0899

PAGE 1

REV A

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH
WAVETEK PROCESS
DRAWN
DATE
PROJ ENGR
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED
XXX ±.010 ANGLES ±1
XX ±.030
DO NOT SCALE DWG
SCALE

WAVETEK SAN DIEGO • CALIFORNIA

TITLE
PARTS LIST
STRAIN RELIEF KIT

MODEL NO 816
DWG NO 002.0899
REV A
CODE IDENT 23338
SHEET 1 OF 1

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